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OTTER-TRAWL FISHERY

LETTER FROM THE SECRETARY OF COMMERCE

TRANSMITTING

COMMUNICATION FROM THE COMMISSIONER OF FISHERIES SUBMITTING A REPORT ON THE OTTER-TRAWL FISHERY, IN COMPLIANCE WITH ITEMS IN THE SUNDRY CIVIL APPROPRIATION ACTS APPROVED AUGUST 24, 1912 AND JUNE 23, 1913

JANUARY 25, 1915.—Referred to the Committee on the Merchant Marine and Fisheries and ordered to be printed, with illustrations

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LETTER OF TRANSMITTAL.

DEPARTMENT OF COMMERCE,
OFFICE OF THE SECRETARY,
Washington, January 22, 1915.

SIR: I have the honor to submit herewith a communication from the Commissioner of Fisheries, transmitting a report on the otter-trawl fishery, in compliance with items in the sundry civil appropriation acts approved August 24, 1912, and June 23, 1913, directing the Commissioner of Fisheries to investigate the method of fishing known as beam or otter trawling and to report to Congress regarding the effects thereof.

Respectfully,

E. F. SWEET,
Acting Secretary.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

COMMUNICATION FROM THE COMMISSIONER OF FISHERIES TO THE SECRETARY OF COMMERCE, TRANSMITTING A REPORT ON THE OTTER-TRAWL FISHERY AND MAKING RECOMMENDATIONS REGARDING THAT FISHERY.

DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, January 20, 1915.

The SECRETARY OF COMMERCE:

There is forwarded herewith, for transmission to Congress, a report embodying the results of an investigation by the Bureau of Fisheries of the method of fishing known as otter trawling. The investigation was undertaken, and this report thereon is submitted, pursuant to the authority contained in the act approved August 24, 1912, making appropriations for sundry-civil expenses of the Government for the fiscal year ending June 30, 1913, as follows:

> To enable the Commissioner of Fisheries to investigate the method of fishing known as beam or otter trawling and to report to Congress whether or not this method of fishing is destructive to the fish species or is otherwise harmful or undesirable, $5,000, or so much thereof as may be necessary.

A similar provision was contained in the sundry civil appropriation act for the following year, the sum voted being for the completion of the investigation.

In anticipation of the foregoing action by Congress, preliminary inquiries were begun on otter trawlers operating out of Boston in June, 1912. On September 30, 1912, Mr. A. B. Alexander, assistant in charge of the division of statistics and methods of the fisheries, was ordered to proceed to Boston and other places to determine on methods for prosecuting the inquiry, but it was not until December 28, 1912, that he was given definite authority to proceed with the work. Mr. Alexander had exclusive charge of the field investigations, with headquarters in Boston, and, with the exception of insignificant intervals, was continuously in the field during the calendar year 1913; and he is responsible for the methods followed and the data collected.

Under the plan of investigation adopted, men in the employ of the Bureau were placed on a number of the vessels, both otter trawlers and trawl liners, to make personal observations and records of the practices of the fisheries and the character of the catch. To each

man there were issued the following instructions and schedule of the salient points at issue:

INSTRUCTIONS FOR OTTER-TRAWL INVESTIGATIONS.

The general purpose of the investigation is to determine the efficiency of the apparatus employed and its effects upon the fishes and the fishery.

The principal points to be considered are as follows:

1. The defining of each separate fishing area over which the trawl was worked. If within sight of land, giving the bearing of the nearest point of land and the distance from shore. If out of sight of land, giving the name of the fishing bank, and, if possible, the latitude and longitude.

2. The days and dates trawling was carried on.

3. The number of times the trawl was lifted each day.

4. The length of time the trawl was down on each occasion before lifting.

5. The speed of the vessel when trawling.

6. The weather conditions each day.

7. The kinds of fish taken from the net after each haul.

8. The quantity of fish, including shellfish, taken in each haul, showing the quantity of each kind and its proportion to the whole catch. (This should be ascertained by actual count or measurement, if possible. If this can not be done, then the closest possible approximation should be made.)

9. The quantity and kind of immature edible fish taken in each haul and the proportion of such to the whole.

10. What disposal was made of such immature fish, and what disposal was made of all nonedible fish taken.

11. The proportion of fish that were alive when each haul was brought on deck, and the kinds mostly found to be alive.

12. If immature and nonedible fish were thrown overboard, the percentage of each kind that were alive when returned to the sea and the percentage that would be likely to survive.

13. The size, up to which the various kinds of fish were regarded as immature and unmarketable by the captain of the trawler.

14. The number of times the trawl was worked over the same piece of ground in succession, showing whether the second or further drags were as successful as the first.

15. Whether fish eggs or spawn (except what might be emitted from the fish in the net by their own weight) were taken on any occasion, and if so, the kinds taken.

16. Whether fry of any fish were taken on any occasion, naming the kinds.

17. Whether ordinary fishing vessels at work were within sight on any occasion during trawling operation, and if so, giving the distance between such vessels and the trawler.

18. Whether any nets, lines, or other fishing gear were carried away or whether the fishing success of such gear was interfered with in any way by the presence of the trawler.

19. Details should be given showing the kinds of gear, where it was set, and the quantity damaged in each instance.

OTTER TRAWLERS.

Urgent representations have been made to this Bureau to the effect that the method of fishing known as otter trawling, which has been introduced on this side of the Atlantic only a few years ago, is such an unduly destructive method that if generally adopted the lines and other gear of ordinary fishing vessels

will be continually carried away and destroyed and the fishing grounds quickly rendered nonproductive. The representations take the following form:

1. That the fishing areas where steam trawlers have already been operating have become seriously depleted of fish.

2. That the spawn or eggs of fish are destroyed by the trawlnet when being dragged along the bottom.

3. That immature fish are taken in very large numbers, which are killed in the process of capture and are thrown away.

4. That valuable shellfish are destroyed in large numbers.

5. That steam trawlers carry on operations at night as well as in the daytime, and that although an effort might be made to keep clear of the ordinary fisherman's gear during daylight, no such effort would be made in the darkness, owing to the invisibility of the buoys and other floating marks.

6. That it is not an uncommon thing for a steam trawler to come close to ordinary fishing vessels and their dories when the gear of the latter is in the water and being overhauled, and, if fish appear plentiful, to sweep around the spot and with the trawlnet carry away the gear with all the fish on the hooks.

7. Further, that while steam trawling has been prohibited within the territorial waters of Canada, such protection affords the inshore fisherman little protection, as their gear is frequently set even long distances beyond territorial waters, and it, of course, affords no protection whatever to the "bank" fishermen.

On the other hand it is urged:

1. That steam trawling is not an unduly destructive method of fishing, as an evidence of which is the fact that it has been intensively carried on in the North Sea and other European waters for very many years without any diminution of the fisheries being apparent.

2. That continuous supplies are necessary to meet the demands of the growing fresh-fish markets, and that as steam trawling can be carried on in practically all weathers, it is the only means of providing such continuous supplies.

3. That edible flat fishes, for which there is an evergrowing market, and which are taken in very limited quantities by hook and line, can be secured in large quantities by steam trawlers.

The men were supplied also with printed forms on which to record full data respecting the date, location, duration, and length of each haul; the numbers and sizes of each species of commercial fish taken; and the numbers and sizes of edible fish of species never, or not usually, placed on the markets. They were required to record, also, all observations of facts bearing on the points in dispute, the condition (living or dead) of the fish thrown overboard, the amount and character of the bottom material brought up in the trawls, any interference with or damage to trawl lines, etc.

The men making the observations on the vessels were:

W. W. Welsh, assistant, Bureau of Fisheries, Washington, D. C.
Thomas M. Douthart, Boston, Mass.
Frank S. Terry, New York, N. Y.
John H. Brennan, Port Clyde, Me.
John N. Burrows, Smithport, Me.
Allan L. Black, McKinley, Me.
Walter H. Rich, Portland, Me.

In addition, Dr. W. C. Kendall, assistant, Bureau of Fisheries, made observations on the flounder otter-trawl fishery of Cape Cod in November and December, 1912; and Mr. E. C. Johnston, assistant, Bureau of Fisheries, investigated the paranzella-net fishery of San Francisco in September and October, 1912.

With the exception of Mr. Terry, who made but one trip, all of these observers had knowledge of the fisheries, although, with the exception of Mr. Burrows, who had fished on a line trawler out of Gloucester 15 years or more previously, none was or had been engaged in either the trawl-line or otter-trawl fisheries. An effort was made to obtain men capable of understanding and reporting on the matters which came under observation and at the same time as free as possible from prejudice by reason of their vocations and previous associations.

During June, 1912, the observers made three trips on otter-trawl vessels and recorded the data of 101 hauls of the nets. From January to December, 1913, 61 trips were made and 1,532 hauls were observed on otter trawlers; and from June to December, 1913, 17 trips and 90 sets of trawl lines were observed on schooners.

The field investigations were brought to a close in December, 1913, and on February 5, 1914, the Commissioner of Fisheries named for the consideration of the data and the preparation of a report a committee of three, of which Mr. A. B. Alexander was chairman and Messrs. H. F. Moore, assistant in charge of scientific inquiry, and W. C. Kendall, scientific assistant, were members. The orders under which this committee proceeded were as follows:

You are hereby designated a committee charged with the duties hereinafter indicated in connection with the investigation of the American trawlnet fishery, as directed by Congress in the sundry civil appropriation act for 1913, as follows:

"To enable the Commissioner of Fisheries to investigate the method of fishing known as beam or otter trawling and to report to Congress whether or not this method of fishing is destructive to the species or is otherwise harmful or undesirable, $5,000, or so much thereof as may be necessary."

Your inquiries will involve, first, a thorough consideration and interpretation of the data collected by the Bureau of Fisheries regarding the steam trawlnet fishery of Boston and New York, the boat trawlnet fishery of New England, the paranzella fishery of California, and other similar fisheries in various parts of the United States, special attention being given to the detailed records obtained by agents of the Bureau while stationed continuously on trawling vessels during the years 1912 and 1913.

For comparative purposes, you will naturally give consideration to the available data showing the present extent and general condition of the trawl fishery in Europe, and the steps that have been taken by the various European countries to regulate, restrict, or abolish the fishery; and the recent history of the fishery in Japan and Canada, and the action of those countries in regulating or abolishing the trawlnet fishery.

It is not my purpose in any way to influence the form and scope of your report, but I venture to suggest that your conclusions cover the following topics, which, with others, will doubtless occur to you:

(*a*) The general effects of the fishery on the permanency of the fish supply, and a comparison of the relative effects of the trawlnet and other forms of apparatus used in the same waters.

(*b*) The nature and extent of the destruction of young food fishes.

(*c*) The destruction or waste of edible fishes that have no present market value.

(*d*) The extent to which the trawlnet fishery of the United States has contributed to the food supply in fishes, not generally taken with other apparatus.

(*e*) Definite instances, supported by evidence, in which the scarcity of any kinds of fish on given grounds may be attributable to the trawlnet fishery.

(*f*) Interference of the trawlnet fishery with other fisheries.

(*g*) The necessity for international agreement with Canada, Newfoundland, France, and other countries in order to make effective any restrictive or prohibitory measures that may be determined to be desirable.

It is believed that in drawing your conclusions and making your recommendations you will be guided solely by the evidence afforded by the Bureau's investigations and by the action of other countries having prolonged experience with this method of fishery.

It is desired that the preparation of your report be expedited as much as possible, and that it be handed to me for administrative approval and submitted to Congress not later than April 15, 1914.

The report speaks for itself and no review thereof by me is necessary. I will simply refer to the chapters containing the conclusions and recommendations, and submit them as the official opinion of the bureau. While I was entirely unaware of the results of the inquiries until the completion and signing of the report, I have carefully reviewed the work of the committee, commend their labors, and indorse their findings as justified by the evidence.

Respectfully,

H. M. Smith, *Commissioner.*

LETTER FROM BUREAU COMMITTEE TO THE COMMISSIONER OF FISHERIES TRANSMITTING REPORT ON THE OTTER-TRAWL FISHERY.

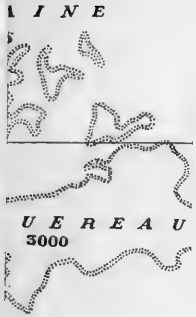
DEPARTMENT OF COMMERCE,
BUREAU OF FISHERIES,
Washington, January 6, 1915.

The COMMISSIONER OF FISHERIES:

We are transmitting herewith our report on the effects of otter trawling on the fisheries, in accordance with your order of February 5, 1914, constituting us a committee for the consideration of the subject. We have been unable to comply with your injunction in regard to the time at which the report was to be rendered for the reason that we speedily found that the data acquired by the field investigations in 1913 were inadequate as a basis for conclusions which would be either just to all interests or commensurate with the importance of the subject. In order to reach any useful conclusions whatever it has been necessary to consider the available facts presented by the history of otter trawling in Great Britain, and we decided that for this purpose it was advisable to go to the original official sources of information rather than to utilize the conclusions arrived at by the various commissions which have investigated the subject, and this has consumed much time, particularly as the inquiry had to be conducted without interference with many other duties.

In reviewing the causes, conclusions, and results of various investigations of trawling in Great Britain, it must be borne in mind that the conditions of the sea fisheries there have always been and still are very different from those in this country. There trawling has undergone a progressive evolution, here it has just begun in a small way at the modern end of that evolution, both in the development of the engines of that method of fishing and the fishes sought.

Therefore the early considerations of the subject of trawling have only a general, if any, application to the question in this country, as the conditions, until recent date at least, are incomparable and a comparison, to be of much value, must be of synchronous and analogous conditions What was concluded by the Royal Commission of 1863, or any other commission or select committee, or the fact that 40 years ago or at any time prior to the advent of steam trawling, and particularly the otter trawl, a great scientist or other authority made



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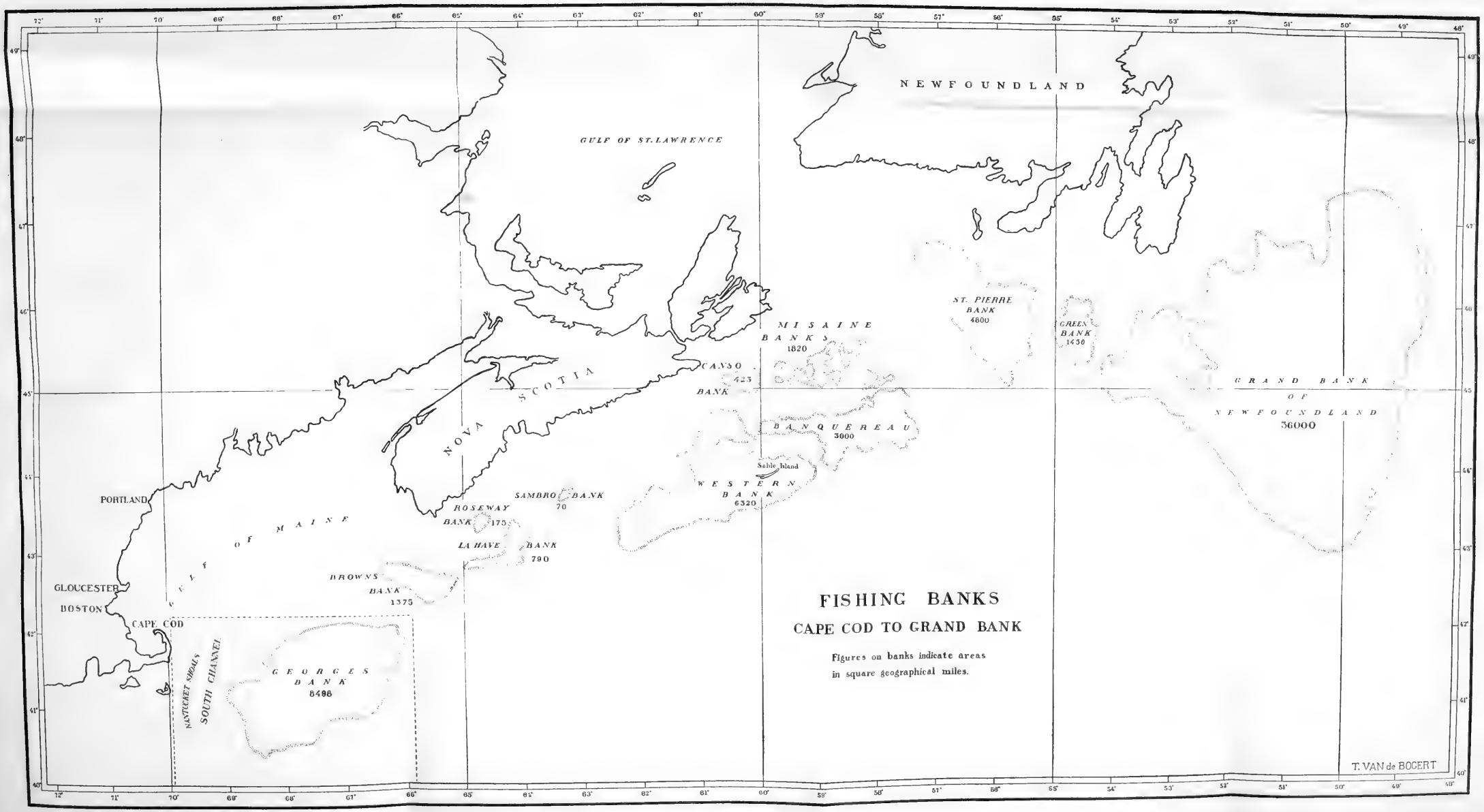

NEWFOUNDLAND
GULF OF ST. LAWRENCE
NOVA SCOTIA
MISAINE BANKS 1820
CANSO BANK 423
ST. PIERRE BANK 4600
GREEN BANK 1430
GRAND BANK OF NEWFOUNDLAND 36000
BANQUEREAU 3000
Sable Island
WESTERN BANK 6320
SAMBRO BANK 70
ROSEWAY BANK 175
LA HAVE BANK 790
BROWNS BANK 1375
GULF OF MAINE
PORTLAND
GLOUCESTER
BOSTON
CAPE COD
NANTUCKET SHOALS
SOUTH CHANNEL
GEORGES BANK 8498
FISHING BANKS
CAPE COD TO GRAND BANK
Figures on banks indicate areas in square geographical miles.
T. VAN de BOGERT

this or that statement or came to this or that conclusion, affects the present question to the extent only that the statement or conclusion holds good at the present day and that it applies on this side of the Atlantic.

Although the present conditions in the fisheries of Great Britain have been reached through changes and progress of many years, and those of this country are of recent and comparatively sudden development, the "bones of contention" have apparently been handed along little changed through the various periods in Great Britain; and finally, still little changed, have crossed the Atlantic to America. When analyzed, the allegations against trawl fishing seem to have had their origin in that one economic factor that has been an ever-present cause of complaint against each and every innovation in fishery methods and appliances in whatever country—competition.

Therefore, most of the investigations and inquiries, while directly ascribable to localized self-interest, have been brought about by allegations mainly of general economic significance. The economic conditions, at least, changed from period to period, and each investigation had a somewhat different problem, and its conclusions and recommendations were in accordance with the evidence presented by the conditions of the time. Our investigations have the same characteristic, and it is not improbable that if we should be called on to conduct a similar inquiry in the future, we might find the conditions so changed as to require conclusions different from those we have now reached.

This committee has based its findings of fact and its conclusions, so far as the conditions on the banks visited by American fishermen are concerned, wholly on the mass of material that has been accumulated in the Bureau of Fisheries; and the opinions of persons other than the members of the committee have been rigorously excluded from consideration.

We are pleased to be able to report complete accord in our deductions and unanimity in our recommendations.

A. B. Alexander.
H. F. Moore.
W. C. Kendall.

REPORT ON THE OTTER-TRAWL FISHERY.

By A. B. Alexander, H. F. Moore, and W. C. Kendall.

INTRODUCTION.

Until 1905, American vessels fishing for demersal or bottom fish on the banks adjacent to the coast of the United States or on the more distant banks off the coast of Newfoundland and Canada confined themselves to the use of hand lines and trawl lines, the nature and methods of the use of which will be described later in this report. This fishery was, and is, conducted solely by sailing vessels.

In the year mentioned, the steamer *Spray* was built at Quincy, Mass., for Boston owners, the Bay State Fishing Co. She was constructed on the general plans of British fishing steamers and was equipped for using the otter trawl, an entirely new method of fishing on the coast of the United States, also described further on in this report. In 1910, two more steam trawlers were built for the same owners, and in each of the years 1911 and 1913 three similar vessels were added to the fleet. In addition, a converted yacht owned in New York began fishing in 1912, and a small vessel owned in Gloucester sometimes uses an otter trawl. In the winter of 1914–15 a menhaden steamer entered the fishery. These, with the *Coquet*, a Scottish vessel which made several trips into New York, are the only vessels which have used otter trawls out of American ports or which have carried fares taken with otter trawls into such ports. The fishery has always been conducted predominantly out of Boston, and at present is practically confined to that place.

Although the merits and demerits of beam trawling and otter trawling, which are essentially similar, had long been the subject of much controversy and numerous investigations in Europe, there never had been occasion for either in the United States until the rapid augmentation of the Boston steam-trawling fleet after 1910 aroused the line fishermen to apprehension concerning the conservation of the fishing banks and a realization that they were face to face with a possible revolution in the methods of fishing.

As an outcome of this alarm, and in response to the appeal of the line fishermen and related fishery interests, the investigation on which this report is based was made.

THE AMERICAN BANK FISHERIES.

GENERAL CONSIDERATIONS.

In comparatively recent years the fishing fleet of the banks has undergone a great change in both model and rig. The introduction of a new class of vessels, having greater speed and superior seagoing qualities than were possessed by the old type, has made it possible to prosecute the fisheries on a larger scale at all seasons, especially during the winter months. In consequence of the increased size of the modern type of vessels, much more fishing gear is now operated per vessel than was customary 30 or 40 years ago. At that time fewer vessels, in proportion to the size of the fleet, were engaged in the market fishery—that is, landing their catch in a fresh condition—and more attention was paid to what is termed salt fishing—that is, the dressing and curing of fish on the banks where caught.

As the demand for fresh fish increased, more vessels became engaged in supplying the market, with the result that in a few years a large fleet was permanently employed in fishing for cod, haddock, and other species throughout the entire year. These vessels fish chiefly on Georges, Browns, and Western Banks, and in the South Channel, although at times many of the inshore grounds are visited. Quick trips are usually made, but there are times when a continuance of gales interrupts fishing for a week or more. Fish that are over two weeks old, as a rule, do not command the price that is realized for those more recently caught; in consequence there is an incentive for the fishermen to land their catch in as fresh condition as possible.

In the early years of the haddock fishery only a small portion of the haddock grounds were resorted to, but as more vessels were added to the fleet and competition arose the accessible grounds were more thoroughly exploited and larger catches resulted.

On Grand Bank, Western Bank, Quereau Bank, and other grounds where halibut were at one time very plentiful, there has, in recent years, been a decided falling off in the catch, and in some places where they were formerly found in abundance, it is no longer considered profitable to fish for them. This condition is thought to have been brought about by overfishing. Grounds that have been depleted in this manner require "rest"; and it has been found that localities which have been abandoned for a considerable length of time furnish a fairly good supply of halibut when again visited.

Taken as a whole, however, the halibut grounds of the western Atlantic are less productive than they were 15 years ago (1899), when the catch of fresh and salted halibut amounted to 9,025,182

pounds, compared with 3,379,580 pounds in 1914. In 1910 the catch was 4,023,999 pounds; in 1911, 3,501,745 pounds; in 1912, 3,541,539 pounds; in 1914, 3,379,580 pounds; the average annual yield in the past five years being 3,947,003 pounds.

The falling off in the amount of halibut landed in some years since 1899 may in a measure be accounted for by the fewer vessels engaged in the fishery, as it has been found unprofitable to send a large fleet of halibut catchers each season to banks where the results were extremely doubtful, especially in view of the fact that larger and more certain returns might be realized from the cod, haddock, or mackerel fisheries. Aside from changes mentioned in the halibut and haddock fisheries, the general condition of the various banks enumerated, with the exception of Georges and South Channel, remains about the same as it was 30 years ago.

In order to make a clear presentation of the underlying differences between the old line fisheries and the new trawlnet fisheries a full description of the respective apparatus and methods is desirable.

HAND-LINE AND TRAWL-LINE VESSELS.

Line trawls have been extensively used by the fishermen of New England for many years. This method of capture has largely supplanted hand lines, although in recent years, at certain periods, a considerable fleet of hand-liners has fished on Quereau Bank and Western Bank with marked success, fishing being carried on from the deck of some vessels and from the dories of others. The first class are known as deck hand-liners and the second as dory hand-liners. Each method is still used in the cod fishery, but trawl-line fishermen greatly outnumber those using hand-lines.

In the inshore fisheries, where formerly hand-lines were wholly used, trawl lines are now the principal means of capture, except on the local fishing grounds off Cape Ann, where gill nets have been extensively employed in the last three years for the capture of pollock, cod, and haddock.

Dory hand-line vessels.—A dory hand-line vessel usually carries from twelve to fourteen 13-foot dories. When not in use they are nested on the main deck, an equal number on each side. In this kind of fishing one man goes in a dory and operates two and three lines, the number being regulated by the depth of water, strength of tide, and other conditions.

Size of lines and leads.—The lines used by dory fishermen on Quereau and other banks, where this method of fishing is largely carried on at times, are tarred cotton, weighing from 8 to 10 pounds per dozen. The leads weigh from 2½ to 3½ pounds each. The depth of water in which fishing is carried on varies from 15 to 50 fathoms,

while with trawl lines the depth is usually greater, 40 to 60 fathoms being a fair average.

Bait.—Salt clams, fresh squid, caplin, fresh herring, and other species are used for bait.

Skill of fishermen.—On good fishing ground a skillful fisherman will load his dory in a comparatively short time, and it is not uncommon, when fish are plentiful, for a boat to be loaded three or four times in a day's fishing. At such times, when there is a considerable fleet of vessels on the bank, the weather being pleasant, it is not unusual for 200 or 300 dories to be fishing side by side. In other localities where fish are less abundant the dories are likely to be more scattered. While the dories are out the skipper and cook generally fish from the deck of the vessel.

Time of fishing.—Generally the men go out in the dories twice each day; the first time being before sunrise and again just before noon. In the middle of the afternoon they return to the vessel and eat their supper, after which they begin to dress the catch.

The number of fish caught by each man is noted by the captain, and upon this record depends each man's share of the proceeds, it having been found that better results follow this system than on vessels where all fish are thrown together, all men sharing alike.

Fishing is continued each day, weather permitting, until a fare has been secured or a scarcity of fish compels the vessel to seek a new berth. Sometimes the voyage is interrupted by the necessity of leaving the bank for a fresh supply of bait.

Deck hand-line vessels.—Vessels of this class often fish on the same ground with dory hand-liners. The crew fish from the deck. The fishing gear is the same as that used in dories, excepting that the leads are heavier.

Trawl-line vessels.—Line trawlers engaged in the market fishery are of two classes, known as single and double fishermen, so called because of one man being required in the single and two men in the double dories. The dories are 12 and 14 feet long, respectively.

Number of dories and amount of gear.—Vessels that land fresh fish from offshore grounds, such as Georges, Browns, Cape Shore, and other banks, carry from 12 to 16 dories. Vessels fishing on local grounds are generally smaller in size and in consequence carry fewer dories.

Ordinarily each dory is furnished with from 4 to 6 tubs of trawl, each tub representing about 500 hooks, seldom exceeding 525 hooks. A flour barrel, sawed off above the lower quarter hoops, is used for a tub. The trawls are coiled in tubs as they are baited, the baited hooks being placed at the side in rows in such manner that they can be thrown out quickly without fouling. A vessel having 12 dories, each dory operating four tubs of trawl, would use 24,000 hooks to a set, and

one having 16 dories 32,000 hooks. The number of tubs to be set is regulated by the abundance of fish, strength of the tide, and weather conditions. On first arriving on the bank it is frequently necessary to test the ground as to the abundance or scarcity of fish. At this time only a small portion of the gear is set, as it is not thought advisable to consume the bait on uncertain ground.

Cod and haddock trawl lines.—Trawl lines consist of two parts, the ground line and the gangings, together with buoys, buoy lines, and anchors. The ground line is a small, tarred cotton line weighing about 14 pounds per one dozen lines of 25 fathoms each. The size of lines varies somewhat. The gangings, to which the hooks are attached, are of tarred cotton line weighing about 5 pounds to 300 fathoms, are 2 feet long, and are fastened to the ground line at intervals of 5 feet, although some vessels employ gear with the hangings placed 38 inches apart, and others 5 feet 9 inches apart. There is no fixed rule governing the number of hooks on a trawl. Vessels engaged in the offshore fisheries generally use gear with the hooks closer together than those employed in fishing on local banks. Captains and crews of vessels entertain different ideas regarding the manner in which trawls should be rigged, and this in a measure accounts for the different styles of gear found on vessels engaged in the same fishery.

Trawls set for both cod and haddock are now rigged practically in the same manner. In past years, however, the hooks and gangings on cod trawls were somewhat larger than on haddock trawls. Smaller gear has gradually come into use, and the haddock trawl has taken the place of the cod trawl on Georges, South Channel, and shore grounds.

Dories and their outfit.—In making a passage to and from the banks and during stormy weather the dories are nested on the deck of the vessel and securely lashed. On arriving on that part of the bank where a set is to be made, the lashings are cast off and preparations made for fishing. Into the top dories of the nest, previous to hoisting out, the necessary fishing gear is placed, consisting of tubs of trawl, buoys, buoy lines, anchors, fish gaff, bait knife, and dory roller. It may be stated that the trawls are baited before being placed in the dories. The other dories are equipped in the same manner by their respective crews, and as soon as ready are hoisted over the side and paid astern, ready to set in the position selected by the captain.

Setting a trawl line.—In setting a trawl two men usually go in a dory, one to throw the trawl and the other to row the boat. Having arrived at the place where the set is to be made, they fasten a buoy to one end of the buoy line and throw it over the side. The buoy line is allowed to run out until the end is reached, when it, together

with the upper end of the trawl line, is bent to the ring of the anchor. The anchor is lowered over the side, and the trawl is then thrown from the tub until the lower end is reached; it is then fastened to the upper end of the second tub of trawl, and so on until all of the tubs—four, six, or more—have been set. The last end of the trawl, together with the second buoy line, is bent to an anchor and thrown over the side, care being taken to prevent the buoy line from fouling with the hooks of the trawl as it runs out. To the free end of the buoy line is attached the second buoy. The distance between the buoys depends on the number of tubs set; sometimes it is a mile or more.

Hauling a trawl line.—At an early hour in the morning the men turn out to their breakfast, following which the dories are hoisted over the side and preparations are made for hauling. In this case the trawls have been left out overnight. There are many times, however, when two sets are made each day and no night fishing is done.

The men row in various directions according to the bearings of their outer buoys. Having reached the buoy, the man in the bow of a dory begins to haul the buoy line, hand-over-hand, over the roller inserted on the gunwale in the forward part of the dory. This is kept up until all the slack is taken in and a strain is brought to bear by the anchor and trawl, when the services of both men are required. The man in the stern unfastens the buoy and coils the buoy line. The anchor having been unbent and stowed away, the man in the bow commences to haul the trawl, which is coiled away in tubs by the man stationed aft, who at the same time takes the fish from the hooks. In this manner the entire "string" of gear is hauled, each section coiled in a tub, the hooks placed in such a position as to make it comparatively easy to rebait them. Before arriving alongside of the vessel everything connected with the trawl is stowed and fastened in such a manner that it can be removed from the dory to the deck without becoming tangled.

Underrunning a trawl.—This method permits the removal of the fish from the hooks and rebaiting them in a single operation, thus saving a considerable amount of labor. "Underrunning" is sometimes performed on ground where fish are plentiful and the weather is suitable for such operation. A trawl intended to be "underrun" is set in the usual manner with slight variation. A becket is made in the buoy line about 10 or 12 fathoms below the buoy. In the becket is bent a small line which reaches to the bottom, and to the bottom end of this line is fastened a stone weighing about 6 pounds. The ground line of the trawl, instead of being fastened to the ring of the anchor, is attached to the small line close to the stone. When thus set there is sufficient distance between the anchor on the buoy line and the stone on the small line to permit

of the trawl being lifted without disturbing the anchor. In hauling, the buoy line is pulled up until the small line running to the anchor is reached, the stone is hauled up and the end of the trawl is passed over the dory. One man unhooks the fish and the other baits the hooks. In this way the dory passes under the entire length of the trawl, the fish being taken from it and the hooks baited in a single operation. The object of operating trawls in the manner described is for the purpose of keeping them in one position during the time fish are plentiful.

OTTER-TRAWL VESSELS.

There are at the present time nine steam vessels regularly engaged in the otter-trawl fishery from American ports. These vessels were designed and constructed especially for this industry. There are also two other steam vessels employed in otter trawling, one a converted yacht, the other a menhaden vessel.

The typical steam otter trawler is a two-masted steel steamer, about 115 feet in length between perpendiculars, with a beam of 22 feet and a depth of 11 to 12 feet, and equipped with an engine of 450 indicated horsepower. The hull is strongly constructed, and shows sturdy, seaworthy lines, with considerable shear. Vessels of this class range in size from 248 to 296 gross tons, and are quite similar in the character and arrangement of their gear.

The forecastle deck is usually built up and covered in with a turtleback, forming a storeroom for fishing gear, and providing a breakwater which prevents the shipping of water over the bow. From here the deck is clear aft to the wheelhouse, which is situated about midships, over the fire room. From this point a low house runs aft in the center of the vessel, leaving a clear passage on both sides, and a considerable space of clear deck at the stern. A low bulwark extends entirely around the vessel.

Just forward of the wheelhouse stands the trawling winch, consisting of two drums, steam driven, on which are wound the two wire cables which operate the net. In front of the winch is a hatch leading to the fish hold.

The forward deck is divided by low, removable partitions, or "checkers," forming a series of pens of various sizes for the retention of fish during the operations of sorting and cleaning.

On each side of the vessel, fore and aft, stand the "gallows;" steel structures which support the sheaves through which the wire cables go outboard. These are usually in the form of an inverted U, inclined slightly outward. The forward pair stand slightly in advance of the foremast, and the after pair about abreast of the mainmast.

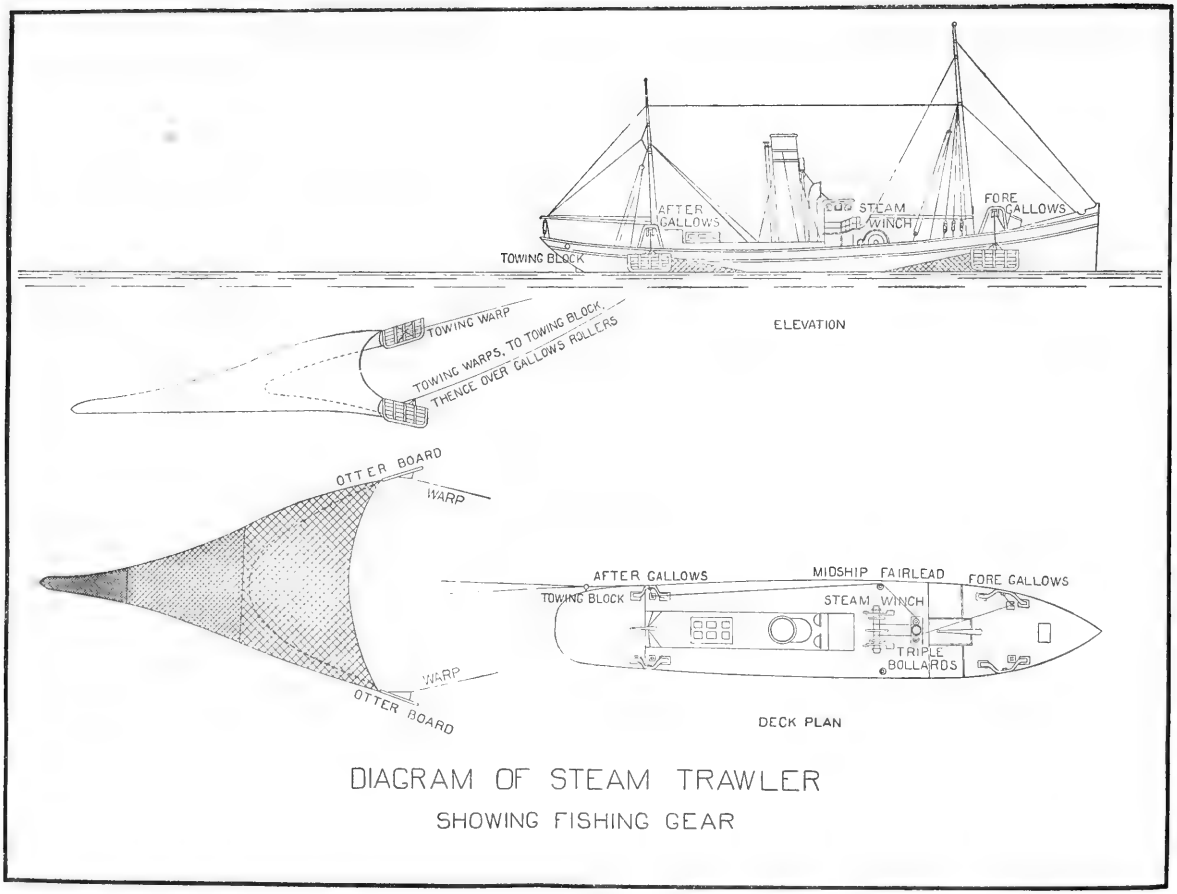


DIAGRAM OF STEAM TRAWLER

SHOWING FISHING GEAR

The otter trawl, as used by steamers fishing out of Boston, is essentially a large, flattened, conical bag, which is towed along the bottom of the sea. The mouth of this bag is kept open laterally by two large boards, or doors, one on each side, so rigged that they operate like kites. These boards are secured to the towing warps by chain bridles, so adjusted that as the trawl is towed along the resistance of the water causes the boards to pull away from each other, thus spreading the bag.

This conical bag is about 150 feet long. That portion of the mouth of the bag which lies on the sea bottom is secured to a foot line 140 feet long, reaching from board to board. The upper edge of the mouth is secured to a shorter headline, 110 feet long, also reaching from board to board. In operation this headline, being shorter, causes the top of the mouth of the bag to extend considerably in advance of the lower portion.

The otter boards are usually about 10 feet long, 4 feet high, and 2½ inches thick and are heavily shod and reinforced with iron. At ordinary towing speed their kite-like action extends the mouth of the net laterally to a width of from 70 to 90 feet. The flow of water into the net tends to keep it open vertically, but this force is assisted by a painted canvas float attached close to the center of the headline.

The foot line is a wire cable served with marline and wound with rope, giving it a diameter of about 4 inches. This wrapping tends to prevent the line from cutting into the bottom, and thus reduces the wear and tear on the net. Chafing gear, consisting of sections of old nets, is used for further protection.

The nets themselves, which are all imported, are constructed of strong manila twine, with a mesh of about 3 inches square in the forward third of the bag. The central third has a mesh about 1½ inches square. In the last third of the net, or cod end, the twine is doubled. This makes the knots larger and reduces the size of the mesh to about 1¼ inches square. The end of the cod end is open and is secured, while fishing, with a draw string.

In setting the trawl, the wire cables are run through fair leads to and through the gallow sheaves, one forward and one aft on the side from which it is proposed to set. The cables are then shackled to the chain bridles of the otter boards, which are in turn secured to either wing of the trawl. The vessel is then brought beam to the wind, the net being on the windward side. The cod end is then tied up and put overboard, the balance of the net being paid out as the vessel drifts to leeward away from it. The float (usually a balloon-shaped canvas bladder) is secured to the center of the top of the bag. The net is now all gone into the water, with the excep-

tion of the ends of the wings, which are attached to the otter boards hanging at the gallows.

Both towing warps are now slowly paid out for a short distance, and the vessel moves slowly ahead, turning toward the side from which the net is being set. This is continued until the otter boards have spread the net properly, and the whole apparatus has assumed the position for fishing. The cables are then paid out until the net has reached the bottom, when they are stopped and shackled together near the stern of the vessel.

The trawl is now towed slowly along the bottom at a rate of from 2 to 3 miles per hour, usually for about 1½ hours. Then the cables are released from the shackle at the stern, the winches are started, and as the net comes up the vessel is again brought broadside to the wind, with the net to the windward, and stopped. The otter boards are brought right up to the gallows blocks, and the net is further brought in by quarter lines run to the gypsy heads of the trawling winches, the crew taking in the slack of the net by hand. When the ends of the quarter lines are in, the foot rope of the net lies close alongside the vessel.

The remainder of the net is taken in over the side by hand until the cod end, which contains the catch, is reached. The throat of the cod end is now folded over and bunched together; a sling is passed around it, to which is attached a fall from the derrick boom on the foremast. A winch now hoists the cod end, with its contents, and swings it inboard, where it is lowered over one of the checkers. The draw string is now released, and the catch falls out onto the deck.

If fishing is to be continued in the same locality, the trawl is immediately again set as before, and the crew start at once to sort, clean, and stow the marketable fish and dispose of the trash. This work is accomplished in the following manner:

Two or more men, armed with pitchforks, attack the pile of fish in the checker, heaving overboard the skates, dogfish, monkfish, and other species considered worthless, and tossing the haddock, cod, and other marketable fishes into separate checkers. Here these fish (excepting the flat fish), are immediately cut and gutted, a stream of salt water from a hose washing away the blood and gurry. The livers of the cod, haddock, etc., are usually saved. The gutted fish are now forked into a bin where they are further washed by a stream of salt water. When this bin is full it is opened by means of a hinged bottom, and the fish fall into the hold, where a man is stationed who packs them away in pens with chopped ice. The flat fish are packed in ice without cutting or cleaning. The fish being

stowed, the hose is turned onto the deck and the checkers cleaned in readiness for the next haul.

Fishing continues day and night The crew is divided into two watches, working six hours each. The average number of hauls per 24 hours, under ordinary circumstances, is about 10 to 12, although this will vary according to the nature of the ground, the amount of net mending necessary, and the weather. Including the passage to and from the fishing grounds, from four days to a week is usually required to get a full fare of fish.

FISHING BANKS OF WESTERN NORTH ATLANTIC

The principal fishing banks of the western North Atlantic and their approximate areas, are as follows:

	Square miles.
Grand Bank	36,000
Green Bank	1,450
St. Pierre Bank	4,800
Quereau Bank	3,000
Misaine Bank	1,820
The Gully	1,200
Western Bank	6,320
Le Have Bank	790
Le Have Ridges	1,575
Roseway Bank	175
Browns Bank	1,375
Seal Island Ground [a]	1,250
Georges Bank	8,498
South Channel (about)	1,300
Total	69,553

Grand Bank.—The Grand Bank lies southeast of Newfoundland, and in area is about equal to all of the other offshore banks combined. It extends from latitude 42° 57′ to 47° 04′ N., and from longitude 48° 06′ to 54° 11′ W.

Its outline is that of an irregular triangle, with sides, respectively, 264, 225, and 264 miles long. In both area and extent of its fisheries the Grand Bank is the most important fishing ground in the world. Its principal fishery is that for cod, which is carried on by vessels from France, the United States, the Canadian Provinces, and Newfoundland. The fishing season lasts from April to October. Halibut also are taken in considerable numbers.

Green Bank.—Green Bank, situated between Grand Bank and St. Pierre Banks, is of comparatively little importance, although one of the best halibut grounds lies in the deep water near its south-

[a] No name is given on the charts, but it is known to fishermen as the Seal Island Ground; it lies between Browns Bank and Seal Island.

ern part. Its length, north and south, is 62 miles, and its width is about 36 miles. Little is known of the abundance of cod on this bank, but vessels from Gloucester, Mass., fish here for halibut.

St. Pierre Bank.—St. Pierre Bank is situated off the center of the southern coast of Newfoundland, and is distant about 10 miles from the islands of St. Pierre and Miquelon. Its length is about 125 miles, its width between 35 and 65 miles. Cod and halibut are the only food fishes found in considerable numbers, although a few cusk and haddock are sometimes taken. The season begins about the first of April and extends until November. Few except French cod vessels and fresh halibut fishermen resort at present to this bank, as other places offer better inducements.

Quereau Bank.—Quereau Bank is one of the most important of the northern banks. It is somewhat rectangular in shape, about 120 by 47 miles in extent, and lies between 44° 04′ and 45° 01′ north latitude, and 57° 10′ and 60° 05′ west longitude. Cod and halibut are the principal fish, but hake, haddock, and cusk also abound. The best season is from May to November, but halibut are found throughout the year off the edges of the bank.

Misaine Bank.—Misaine Bank lies north of the western two-thirds of Quereau Bank, from which it is separated by a channel about 20 miles wide. Its greatest length and width are 80 and 40 miles, respectively.

The Gully.—The Gully is the deep passage lying between Quereau Bank and Sable Island. It is an important place for halibut, the grounds proper being limited to that portion of The Gully between the meridians of 50° and 60° west longitude. Most of the vessels resorting to The Gully are from Gloucester, Mass.

Sable Island Bank or Western Bank.—This is one of the most important fishing grounds of the western Atlantic. It lies south of Cape Breton Island and the eastern part of Nova Scotia, between 42° 55′ and 44° 46′ north latitude and 59° 04′ and 82° 35′ west longitude, and is about 156 miles long and 76 miles wide. At its eastern end is Sable Island. Cod and halibut are the principal food fish taken, the former being most abundant from March to June. Vessels from all along the New England coast and the British Provinces resort to this bank for cod, but the halibut fishery is almost exclusively carried on by the Gloucester fleet.

Le Have Bank.—This bank lies between 42° 34′ to 43° 25′ north latitude, a distance of 52 miles, and 63° 50′ to 65° 07′ west longitude, a distance of about 54 miles. Cod and haddock are the principal species taken. These are found at all seasons of the year, but are most abundant during the early winter months.

Le Have Ridges.—Le Have Ridges is an eastern continuation of Le Have Bank, with a length of about 45 miles. Halibut, cod, and hake are the principal species taken.

Roseway Bank.—Roseway Bank lies north of the western part of Le Have Bank and southeast of Shelburne Light, Nova Scotia, and is of small extent, about 21 by 15 miles. Cod, haddock, and cusk are the principal fish taken, but hake, pollock, and halibut also occur. It is mainly resorted to by small vessels from Nova Scotia, although a few from New England occasionally fish there.

Browns Bank.—Browns Bank lies northeast of Georges Bank, from which it is separated by a gulley 15 miles wide. It is about 63 miles long by 43 miles wide. Cod, halibut, and haddock are the principal fish, but pollock and hake are also found. Cod and haddock are quite plentiful in winter.

Seal Island Ground.—Seal Island Ground is a direct continuation of the shore soundings, extending south nearly to Browns Bank, and northwest to about 35 miles beyond Seal Island. Cod, haddock, and pollock are the principal fishes, but halibut, cusk, and hake are also taken, and occasionally herring and mackerel. The fleet resorting there is composed chiefly of Nova Scotia vessels.

Georges Bank.—Georges Bank is the largest and most important ground near the coast of the United States and is second only to Grand Bank in these respects. It lies to the eastward of Cape Cod and Nantucket Shoals, between 40° 30′ to 42° 08′ north latitude and 66° to 69° west longitude. Its greatest dimensions are about 150 by 98 miles. On its western part are a number of dangerous shoals. During February, March, and April large schools of cod and haddock appear on this bank, usually on the "winter fishing grounds," whose area is about 11 square miles.

South Channel.—South Channel is practically an extension of Georges Bank, or that part of it lying west of 69° west longitude and between 40° 45′ and 41° 45′ north latitude and includes the ground covered by Nantucket Shoals and as far north as Chatham Lights. It is a very prolific ground for haddock and is resorted to by the Boston and Gloucester fleets. Its closeness to the markets makes it possible to land fresh fish in excellent condition.

COMPARISON OF THE CATCH BY OTTER-TRAWL AND TRAWL-LINE VESSELS.

The character of the catch, as measured by the number, and especially by the relative proportions of the species taken, varies with the time of year as well as with the apparatus employed, as will be seen from the following table, based on the records of observers stationed on both otter trawlers and line trawlers during the year 1913.

PERCENTAGE OF MARKETABLE AND UNMARKETABLE SPECIES OF FISHES TAKEN BY OTTER TRAWLS AND TRAWL LINES, RESPECTIVELY, IN 1913, ON CERTAIN VESSELS.

Species.	Otter trawls.		Trawl lines, June to December.
	January to May.	June to December.	
Marketable species, saved:	*Per cent.*	*Per cent.*	*Per cent.*
Cod	4.4	3.6	8.8
Haddock	70.3	36.6	35.6
Hake	.6	2.0	11.0
Pollock	.2	.3	.8
Cusk	.....	(a)	2.6
Wolf fish	.1	(a)	(a)
Halibut	(a)	.1	.1
Sole	4.0	1.3	.1
Butterfish	.....	.7	.....
Rosefish	.....	3.8	1.6
Lobster	(a)	(a)	.....
Total marketed	79.6	48.4	60.6
Immature marketable species, wasted:			
Cod	.2	2.4	(a)
Haddock	9.1	22.3	.1
Hake	.9	15.2	7.5
Pollock	(a)	(a)	.....
Halibut	.1	(a)	.....
Sole	.2	.....	.....
Total	10.5	39.9	7.6
Nonmarketable species, wasted:			
Silver hake	.5	3.3	5.1
Flounders	4.0	2.7	1.3
Monkfish	.6	1.1	.5
Dogfish	2.4	2.8	21.2
Skate	2.3	1.8	3.5
Total	9.8	11.7	31.6
Total waste, all species	20.3	51.6	39.2

[a] Less than 0.1 per cent.

This is a record of the catch, not of the fares landed, and it includes the marketable, the unmarketably small of the marketable species, and the species which have no present market value. The question of the sizes of these fish will be considered later. All cod, haddock, hake, pollock, cusk, halibut, and sole of suitable size are saved, while wolf fish, butterfish, and rosefish are sometimes saved and sometimes thrown away. The "nonmarketable species" are all edible fish, but are not utilized in American markets.

It will be observed that there is but little change in the proportions of marketable and nonmarketable species taken by the otter trawls in the first and second halves of the year, respectively, but that during the period from June 1 to December 31 the trawl lines catch a much larger proportion of nonmarketable species than do the otter trawls, the difference being due to the larger number of dog-fishes taken on the lines, 21.2 per cent of the whole catch as compared with 2.8 per cent taken in the nets. During this period the otter trawls observed took 88.2 per cent of marketable species and the trawl lines 68.3 per cent, and of the nonmarketable species

the nets took 11.7 per cent and the lines 31.7 per cent. Eliminating the dogfish, the proportion of total nonmarketable species taken by the two methods did not differ materially.

The waste of marketable species too small for sale was comparatively small in the otter-trawl fishery from January to May inclusive, not being materially higher than the catch of immature fish on lines in the latter half of the year, but from June to December, inclusive, the otter trawls were relatively almost five times as destructive of small fish as the lines.

On the vessels under observation the lines took no young cod and practically no young haddock, while 2.4 per cent of the whole catch of the otter trawlers consisted of young cod and 22.3 per cent of young haddock regarded as too small to sell. Stated in another form, 40 per cent of the cod and 38 per cent of the haddock taken by the otter trawlers from June to December were fish too small to market. From January to May but 3 per cent of the cod and 11 per cent of the haddock were unmarketable on account of their size.

The foregoing data are based on the entire catch of all vessels observed; since they cover trips to a number of banks and the returns for the two methods of fishing are not strictly comparable, for the steam trawlers and liners were in many cases not fishing on the same grounds, the following table has been prepared:

PERCENTAGE OF MARKETABLE AND UNMARKETABLE SPECIES OF FISHES TAKEN BY CERTAIN OTTER TRAWLERS ON GEORGES BANK AND SOUTH CHANNEL, RESPECTIVELY, AND BY LINE TRAWLERS IN SOUTH CHANNEL, FROM JUNE TO NOVEMBER, INCLUSIVE, 1913.

Species.	Otter trawls, June–November.		Trawl lines, June–November, South Channel.
	Georges Bank.	South Channel.	
Marketable species, saved:	*Per cent.*	*Per cent.*	*Per cent.*
Cod	3.7	3.7	7.8
Haddock	45.5	30.9	41.1
Hake	3.6	.8	9.6
Pollock	.2	.3	1.2
Cusk	(a)	(a)	2.3
Wolffish	(a)	(a)	(a)
Halibut	(a)	.1	.1
Sole	.8	1.6	(a)
Butterfish	1.0	.5	1.7
Rosefish	1.8	5.9	.....
Lobster	(a)	(a)	.....
Total marketed	56.6	43.8	63.8
Immature marketable species, wasted:			
Cod	2.0	2.7	(a)
Haddock	21.9	22.4	(a)
Hake	8.0	19.2	8.3
Pollock	(a)	(a)	.....
Halibut	(a)	(a)	.....
Sole	.....	.....	.....
Total	31.9	44.3	8.3

a Less than 0.1 per cent.

PERCENTAGE OF MARKETABLE AND UNMARKETABLE SPECIES OF FISHES TAKEN BY CERTAIN OTTER TRAWLERS, ETC.—Continued.

Species.	Otter trawls, June–November.		Trawl lines, June–November, South Channel.
	Georges Bank.	South Channel.	
Nonmarketable species, wasted:	*Per cent.*	*Per cent.*	*Per cent.*
Silver hake	2.1	4.3	6.1
Flounders	2.0	3.4	.5
Monkfish	1.0	1.0	.3
Dogfish	4.4	1.7	18.0
Skate	2.0	1.6	3.0
Total	11.5	12.0	27.9
Total waste, all species	53.4	56.3	36.2

[a] Less than 0.1 per cent.

An analysis of this table shows considerable difference between the catches made by otter trawls on Georges Bank and South Channel during the same part of the year. The former ground produced a large proportion of merchantable species of fishes and a correspondingly small proportion of immature individuals. Again, considering the cod and haddock, it is found that the former ground relatively to the entire catch produced 3.7 per cent of marketable size and 2 per cent of immature fish and the latter 45.5 per cent and 21.9 per cent respectively of the two sizes. In other words, 35 per cent of all cod and 33 per cent of all haddock were too small to market.

In the South Channel fishery, 3.7 per cent of the whole catch consisted of marketable cod and 30.9 per cent of marketable haddock, while the young of these species constituted 2.7 per cent and 22.4 per cent, respectively. In the line fishery in South Channel, 7.8 per cent of the whole catch consisted of marketable cod and 41.1 per cent of marketable haddock, and there were practically no young of these species. While all of the cod and haddock taken on lines were marketable, but 67 per cent of the cod and 58 per cent of the haddock taken in the otter trawls were saved, the remaining 33 per cent and 42 per cent respectively being too small to sell. Summarizing, while the otter trawls were considerably less destructive to the young of marketable fishes on Georges Bank than in South Channel, they were in both cases incomparably more destructive than the lines fished in South Channel or on all of the other grounds collectively.

The young fish not large enough to market are thrown overboard from the vessels in the case of the otter trawlers and from the dories in the line fishery. The testimony of the observers on the vessels is that a very large percentage or practically all of the immature fishes of marketable species are dead when thrown over from the steamers,

and the large percentages of young cod, haddock, and hake shown in the preceding tables are to be regarded as an absolute waste. The young fishes taken on the lines have a much better chance to live, as they have not been subjected to the pressure to which the netted fish are exposed and are immediately returned to the water, although some of them are killed or injured by being "slatted" against the sides of the dories.

In respect to the catch of unmarketable species there is not much difference if the dogfish be eliminated from consideration. All of the waste species enumerated in the table are edible and most of them are regarded with considerable favor in Europe. The dogfish has long been eaten and the demand for it in Great Britain is steadily increasing, but its only economic aspect in the United States is that of a nuisance to the fisheries. The monkfish is one of the most highly esteemed fishes in Germany, and the skate has wide consumption in various parts of the world. Both the flounder and the silver hake are good fishes.

WASTE FROM MARKETING SMALL FISHES.

The foregoing deals with the catch as a whole and the waste which results from the fish discarded as unmarketable. There remains to be considered such waste as may result from marketing an undue proportion of small fishes which, if permitted to live, would not only increase in size and thereby mechanically augment the volume of fish in the sea, but would further increase the supply by procreation. To develop the extent and character of such waste as may occur through the predominance of small fish in the catch the following tables are presented:

WEIGHT AND PERCENTAGE, BY CULLS OR SIZES, OF COD, HADDOCK, AND HAKE MARKETED BY OTTER TRAWLERS AND TRAWL LINERS FISHING ON ALL BANKS IN 1913.

Species and sizes.	Quantity.		Percentage.	
	Otter trawls.	Trawl lines.	Otter trawls.	Trawl lines.
	Pounds.	*Pounds.*		
Cod:				
Large	409,559	6,927,763	24.56	43.16
Market	1,119,975	8,099,221	67.15	50.46
Scrod	138,272	1,023,129	8.29	6.38
Total	1,667,806	16,050,113	100.00	100.00
Haddock:				
Large	10,366,002	30,265,920	83.00	6.31
Scrod	2,122,990	1,159,795	16.99	3.69
Total	12,488,992	31,425,715	99.99	100.00
Hake:				
Large	99,890	3,411,107	47.68	38.22
Medium	109,595	5,513,336	52.32	61.78
Total	209,485	8,924,443	100.00	100.00

The preceding table includes practically all of the cod, haddock, and hake marketed at Boston during the year, and it will be seen that not only, as has been previously shown, do the otter trawlers catch a larger proportion of the small fish than do the trawl liners, but the fish marketed are smaller in the cases of the cod and the haddock, although the reverse is true in respect to the hake. The regulations of the New England Fish Exchange at Boston prescribe the following weights of the several sizes in "culls" of these three species:

Cod:
- Large, 10 pounds and up.
- Market, over 2½ pounds to 10 pounds.
- Scrod, 1 pound to 2½ pounds, inclusive.

Haddock:
- Large, over 2½ pounds.
- Scrod, 1 pound to 2½ pounds, inclusive.

Hake:
- Large, 6 pounds and over.
- Medium, over 2½ pounds to 6 pounds.

We have at hand no data showing the average weights of the fishes of the several "culls," and the table presented can not be interpreted to show the economic loss due to the capture of a predominance of small fishes, even though they be marketed. Moreover, the table shows the catch from all banks, on many of which the otter trawlers fished but little or not at all. The only fishing ground for which there are sufficient data for a comparison of simultaneous fishing operations by both methods is South Channel, and the observed facts in respect to that locality are presented in the following table:

PERCENTAGES BY COUNT OF CULLS OR SIZES OF COD, HADDOCK, AND HAKE MARKETED BY OTTER TRAWLERS AND TRAWL LINERS, RESPECTIVELY, FISHING IN SOUTH CHANNEL FROM JUNE TO SEPTEMBER, 1913.

Species and sizes.	Otter trawlers.	Trawl liners.
Cod:		
Large	6.08	22.62
Market	71.50	69.15
Scrod	22.42	8.23
Total	100.00	100.00
Haddock:		
Large	71.81	82.16
Scrod	28.19	17.84
Total	100.00	100.00
Hake:		
Large	40.57	76.70
Medium	59.43	23.30
Total	100.00	100.00

This table differs from its predecessor in that the percentages are based on the number instead of the weight of the fishes marketed, and the loss resulting from the capture of an undue pro-

portion of small fishes is more clearly brought out. One large cod, for instance, weighs at least four times as much as a scrod, yet each scrod taken is, barring accidents and enemies, a potential large cod. We have, however, no way of determining the age or weight "expectancy" of the average scrod, and any consideration of the probabilities would be mere unfounded speculation. It is clear, at least, that the otter trawl not only destroys more fish too small to market, but it is also more wasteful than the line fisheries by reason of the smaller average size of its marketable catch.

EDIBLE FISHES WASTED AND NEW KINDS MARKETED.

There is another type of waste which has not yet been considered. Failure to utilize a resource which from its nature is not imperishable is almost as economically indefensible as to needlessly destroy part of a product the other parts of which are utilized. Every edible or otherwise economically valuable fish left in the sea beyond the requirements of the maintenance of the species, or to serve as food for other species which are used, is a loss so long as the need of man for protein-bearing food remains unsatisfied. A waste of a recognized food species by any given method of fishing may become justifiable if large quantities of previously unutilized species, not possible to take by other apparatus, be made available to consumers. In final analysis the consumers' interest is paramount, and the real purpose of a fishery is that the people may have fish, both immediately and for all time.

The species of flounder locally known as "sole" is practically the only fish marketed by the otter trawlers which does not feature in the market returns of the trawl liners. These fish average about 3 pounds in weight. During the period from January to May, inclusive, 4 per cent, and from June to December, inclusive, 1.3 per cent by count, of all of the fish caught by otter trawls consisted of soles, all or practically all of which were marketed, while the quantity of this species caught on lines was negligible. During 1913 the trawlers marketed an average of about 50,000 pounds of sole per month, or 600,000 pounds per year. This is about three times the total quantity of marketable hake, 36 per cent of the saleable cod, and nearly 5 per cent of the haddock marketed from the same source. It is therefore a material addition to the food supply.

The average weight of the young cod, haddock, and hake killed and thrown away by the otter trawlers is not definitely known, but it is believed to be at least three-fourths of a pound. On this assumption, the total quantity of soles marketed by the otter trawlers is but one-third of the weight of small gadoids destroyed. As has been before pointed out, the catch of the young of these fish by trawl liners is comparatively negligible. Without considering the question of the potentiality for growth of these young fish and

their value for the perpetuation of the fisheries, the quantity of them destroyed is not compensated for by the catch of sole.

The wolf fish or catfish is also taken more frequently in otter trawls than on the lines, but the entire quantity marketed by the trawlers did not exceed 75,000 or 80,000 pounds in 1913.

Of the edible though unutilized fishes taken by the two methods of fishing, the otter trawlers take more flounders and monkfish and the liners more silver hake and dogfish, while there is not much difference in the relative quantities of skates. Although several species of skates are highly regarded in other countries, it does not appear that any determined effort has been made to establish a market for such fishes in the United States. The relative prices of fishes are to a very large extent controlled by local taste, custom, and prejudice. For instance, the silver hake which is thrown away by American bank fishermen is the highest priced of the Irish demersal fishes (excepting flat fishes), the haddock being next in price. The skate sells in that country for but about 10 per cent less than the cod, and in England the fishermen receive for dogfish but 50 per cent less than for cod. In Germany the monkfish sells for much more than fresh mackerel. There is nothing to indicate, therefore, that the otter trawlers added greatly to the supply of fish food by the introduction in the markets of fishes which are not yielded in considerable quantities by the line fisheries, although their catch is such as to apparently make this to some extent possible.

FLUCTUATIONS IN THE CATCH AND EVIDENCES OF IMPOVERISHMENT OF THE FISHERY.

It is hardly to be expected that a fishery so recently established and of such moderate development as otter trawling in the United States would have any apparent effect on the abundance of fishes, but it has been alleged that a diminution of the catch of demersal fish already has become apparent, and it is necessary to examine the evidence in respect to the allegation. The statement made is that the beginning of the effects of otter trawling on the abundance of fishes on the banks became apparent during 1913 in the quantity of fish landed at Boston. The following table gives the landings at that port for a series of years:

Year.	Pounds.	Value.	Year.	Pounds.	Value.
1909	84,794,303	$2,225,383	1912	104,978,427	$2,718,304
1910	96,341,387	2,611,813	1913	92,317,920	2,869,472
1911	99,020,127	2,705,861	1914	92,252,880	2,622,919

This table shows that there was a gradual increase in the total catch from 1909, when there was but one otter-trawl vessel, until and including 1912, when there were six in commission, but that in 1913,

when three more entered the fishery, there was a sudden fall in the quantity, though a slight increase in the value of the fish landed. In 1914 about the same quantity of fish was taken as in the preceding year.

This may be the result of the operation of any one or several of a number of factors, among which may be mentioned the condition of the markets for fish and labor, the weather, the natural irregularities of the migrations of the fishes themselves or an actual decrease in the fishes due to the fisheries or to natural causes. That the falling off in quantity was not due to a decrease in demand is indicated by the considerably higher price per pound brought by the fish in 1913 as compared with the preceding year.

That for several years there has been a deficiency of fishermen to man the schooners in the line fishery is well known. This is due partly to the introduction of gill netting in the fishery for cod and haddock, which withdrew a number of men from the line fisheries, and partly to the migration of a number of the fishermen to the Pacific coast. Also, a number of schooners have been sold to persons in Nova Scotia and elsewhere, and this, together with the paucity of men, has reduced the activity of the line fishery. From 1908 to 1914 the number of trips of line-caught fish landed at Boston fell from 4,493 to 3,089, a reduction of 31 per cent. To eliminate this factor as far as possible and to reduce the catch to a basis of a unit of effort expended in making it, tables and diagrams showing the fish landed at Boston for a period of years are presented.

QUANTITIES OF COD, HADDOCK, AND HAKE TAKEN ON ALL BANKS BY AMERICAN LINE VESSELS LANDING THEIR CATCH AT BOSTON AND GLOUCESTER, 1891 TO 1914, INCLUSIVE.

Year.	Number of trips.	Cod.		Haddock.		Hake.		All kinds.	
		Per trip.	Total.	Per trip.	Total.	Per trip.	Total.	Per trip.	Total.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1891	4,119	4,043	16,655,200	8,220	33,860,197	2,997	12,347,730	15,261	62,863,127
1892 [a]									
1893	3,826	4,201	16,075,290	8,162	31,229,350	3,029	11,590,400	15,393	58,895,040
1894	4,537	4,780	21,687,330	8,706	39,502,450	3,275	14,863,100	16,762	76,052,880
1895	4,271	4,674	19,965,150	8,475	36,199,900	2,457	10,497,400	15,608	66,662,450
1896	4,187	4,836	20,251,160	6,904	28,909,200	1,560	6,535,300	13,302	55,695,660
1897	4,085	5,196	21,229,700	6,760	27,614,750	1,613	6,590,500	13,570	55,434,950
1898	3,491	4,263	14,882,500	6,235	21,769,300	2,114	7,382,430	12,613	44,034,230
1899	3,866	5,091	19,684,550	6,504	25,145,160	2,196	8,489,800	13,791	53,319,510
1900	3,731	4,748	17,717,650	7,567	28,235,850	1,853	6,917,100	14,170	52,870,600
1901	3,403	4,963	16,892,450	7,267	24,731,350	2,191	7,457,850	14,423	49,081,650
1902	3,981	5,836	23,233,900	8,575	34,138,850	2,065	8,223,850	16,477	65,596,600
1903	3,818	5,600	21,381,350	9,747	37,216,200	2,519	9,617,750	17,866	68,215,300
1904	4,056	4,605	18,678,525	10,087	40,916,300	2,775	11,258,100	17,468	70,852,925
1905	4,280	5,811	24,872,200	12,313	52,700,650	2,223	9,516,500	20,347	87,089,350
1906 [a]									
1907 [a]									
1908	4,493	6,258	28,119,400	8,518	38,272,500	2,764	12,419,500	17,540	78,811,400
1909	4,740	5,417	25,678,900	7,756	36,766,255	2,404	11,395,000	15,578	73,840,150
1910	4,487	5,744	25,777,210	9,364	42,016,820	3,644	16,353,100	18,753	84,147,130
1911	3,793	5,573	21,139,800	10,630	40,320,200	2,949	11,186,225	19,152	72,646,225
1912	3,381	6,347	21,460,350	11,774	39,810,500	3,335	11,276,050	21,457	72,546,900
1913	3,250	5,577	18,127,912	10,313	33,519,547	3,046	9,900,945	18,937	61,548,404
1914	3,089	6,527	20,163,129	10,349	31,970,866	2,327	7,190,065	19,204	59,324,060

[a] Data not available.

The preceding table and the following diagram based on it apply to the three most important food fishes of the banks—the cod, haddock, and hake—and reduce the catches for the several years enumerated to a common basis of the average yield per trip, which, within certain limits, may be considered as indicating the relative annual abundance of the fish in the regions frequented by the fishing fleets.

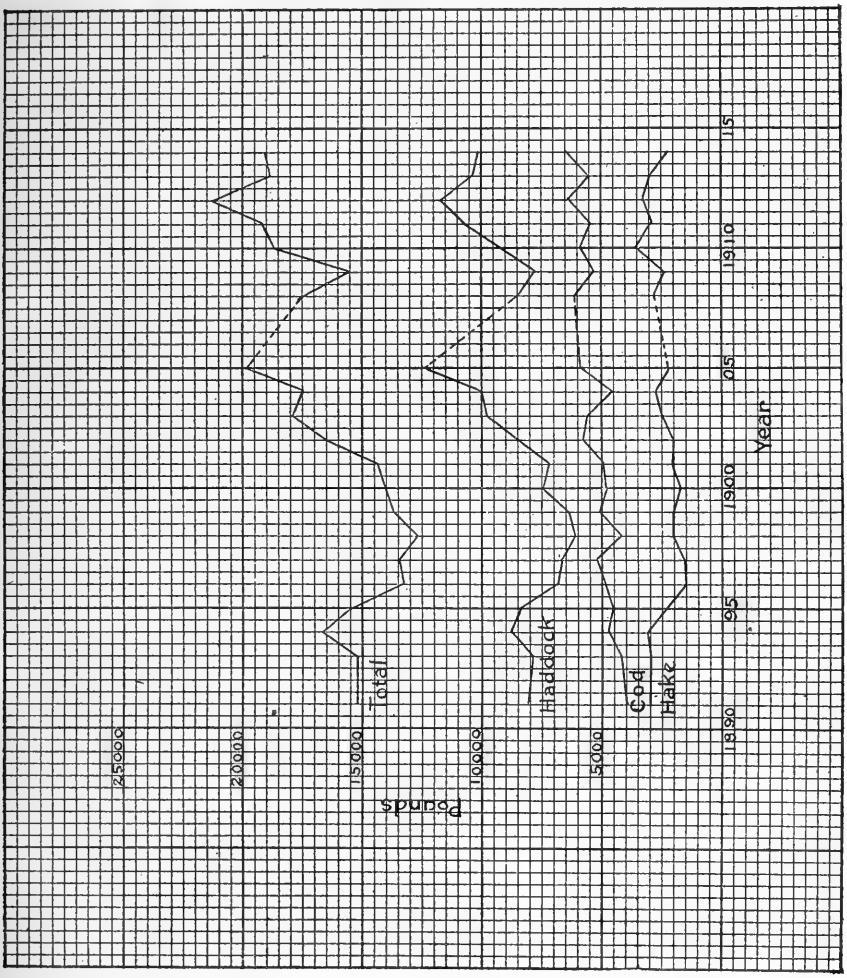


Diagram showing the catch per trip by American line vessels fishing on all banks.

The yield per trip of trawl liners fishing on all banks was less in 1914 than in 1912, but was equal to or more than in three of the five years immediately preceding, and this is true not only of the aggregate, but essentially true of each of the species named. There is, furthermore, a general upward trend of the catch per trip from about 1896 to the present time, and the average since 1910, when the

steam-trawl fleet began to increase, has been higher than for any preceding like period since 1891. There is, therefore, no statistical evidence of a decrease on the fishing banks as a whole.

A majority of the trips represented in this table were made to banks on which the otter trawlers fish little or not at all, and the point may be raised that the destructive effects of the trawls might be masked by the returns of fish from distant banks which were not affected. To examine into this phase of the subject and to develop the locale of such diminution as may have occurred, the following tables and diagrams have been prepared:

QUANTITY OF COD, HADDOCK, AND HAKE TAKEN ON ALL GROUNDS EXCEPT GEORGES BANK, SOUTH CHANNEL, AND NANTUCKET SHOALS BY AMERICAN LINE VESSELS LANDING THEIR CATCH AT BOSTON AND GLOUCESTER, 1891 TO 1914, INCLUSIVE.

Year.	Number of trips.	Cod.		Haddock.		Hake.		All kinds.	
		Per trip.	Total.	Per trip.	Total.	Per trip.	Total.	Per trip.	Total.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1891	2,909	2,882	8,384,200	5,034	14,643,997	4,060	11,812,605	11,976	34,840,802
1892 [a]									
1893	2,586	2,985	7,719,690	4,728	12,226,750	2,985	7,720,000	10,698	27,666,440
1894	3,130	3,473	10,873,430	4,792	14,999,350	2,911	9,113,200	11,177	34,985,980
1895	2,814	3,049	8,580,750	4,804	13,518,900	1,987	5,593,000	9,841	27,692,650
1896	2,691	2,861	7,701,260	4,018	10,813,900	1,128	3,035,600	8,008	21,550,760
1897	2,784	3,140	8,743,100	3,871	10,778,050	1,212	3,376,000	8,224	22,897,150
1898	2,515	2,612	6,649,900	3,536	9,000,150	1,435	3,652,230	7,584	19,302,280
1899	2,688	3,529	9,488,350	3,266	8,779,460	1,527	4,105,200	8,323	22,373,010
1900	2,540	3,478	8,835,650	4,144	10,526,650	1,247	3,168,500	8,870	22,530,800
1901	2,504	3,643	9,123,850	4,380	10,968,350	1,840	4,608,750	9,864	24,700,950
1902	2,520	4,006	10,095,650	4,734	11,931,850	1,312	3,307,950	10,053	25,335,400
1903	2,419	4,210	10,184,750	6,220	15,048,500	1,758	4,253,050	12,189	29,486,300
1904	2,461	2,958	7,281,225	5,170	12,725,700	2,218	5,459,900	10,348	25,466,825
1905	2,378	2,881	6,850,000	6,328	15,049,450	2,050	4,877,100	11,260	26,776,550
1906 [a]									
1907 [a]									
1908	2,988	3,398	10,155,000	5,313	15,875,400	2,059	6,151,500	10,770	32,181,900
1909	3,373	3,174	10,706,500	5,960	20,105,150	2,248	7,584,600	11,383	38,396,250
1910	3,126	3,364	10,516,100	5,630	17,599,550	3,871	12,102,300	12,865	40,217,950
1911	2,806	4,203	11,795,550	5,336	14,974,200	2,567	7,204,125	12,107	33,973,875
1912	2,209	4,406	9,733,950	6,545	14,459,300	2,943	6,502,650	13,896	30,695,900
1913	2,242	3,927	8,805,648	7,609	17,060,431	3,096	6,941,526	14,633	32,807,605
1914	2,153	6,469	13,929,217	6,460	13,909,607	2,760	5,944,051	15,691	33,782,875

[a] Data not available.

The otter trawls have been used almost exclusively on Georges Bank, South Channel, and Nantucket Shoals; and it will be seen that, excluding these grounds, the catch per trip of cod, haddock, and hake, collectively, by liners, has exhibited a gradual and almost uninterrupted increase from 1908 to 1914, the aggregate gain during that time being nearly 45 per cent. So far as the individual species were concerned, the catch of cod per trip in 1914 was larger than in any other year enumerated; the catch of haddock was larger than in any year, except 1912 and 1913, being much smaller than in 1913; and of hake about as many were caught as in any year, excepting 1891 and 1910.

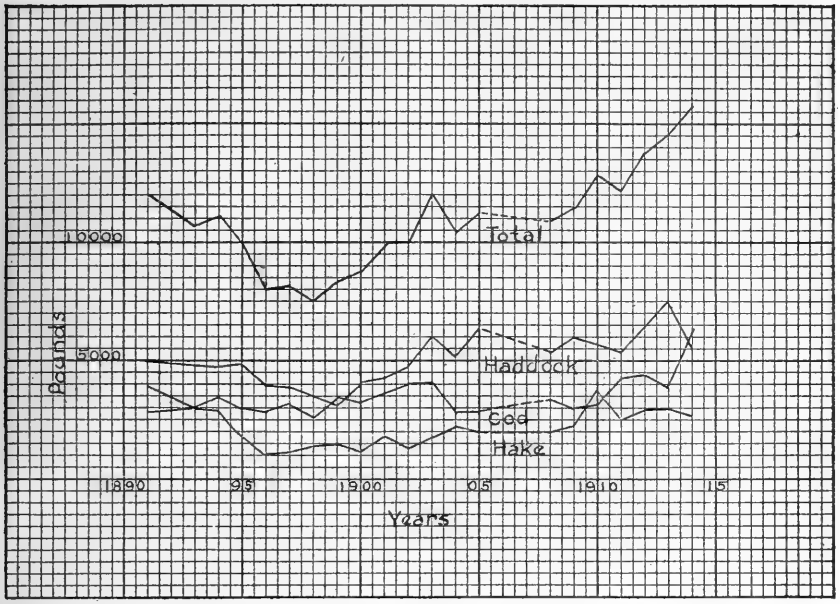


Diagram showing the catch per trip by American line vessels fishing on all grounds except Georges Bank, South Channel, and Nantucket Shoals.

QUANTITY OF COD, HADDOCK, AND HAKE TAKEN ON GEORGES BANK, SOUTH CHANNEL, AND NANTUCKET SHOALS, BY AMERICAN LINE VESSELS LANDING THEIR CATCH AT BOSTON AND GLOUCESTER, 1891 TO 1914, INCLUSIVE.

Year.	Number of trips.	Cod.		Haddock.		Hake.		All kinds.	
		Per trip.	Total.	Per trip.	Total.	Per trip.	Total.	Per trip.	Total.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1891	1,210	6,835	8,271,000	15,881	19,216,200	442	535,125	23,158	28,022,325
1893[a]	1,240	6,738	8,355,600	15,324	19,002,600	3,121	3,870,400	25,184	31,228,600
1894	1,407	7,685	10,813,900	17,415	24,503,100	4,086	5,749,900	29,187	41,066,900
1895	1,457	7,813	11,384,400	15,566	22,681,000	3,366	4,904,400	26,746	38,969,800
1896	1,496	8,388	12,549,900	12,095	18,095,300	2,339	3,499,700	22,824	34,144,900
1897	1,301	9,597	12,486,600	12,941	16,836,700	2,470	3,214,500	25,000	32,537,800
1898	946	8,702	8,232,600	13,498	12,769,150	3,943	3,730,500	26,143	24,731,950
1899	1,178	8,655	10,196,200	13,892	16,365,700	3,722	4,384,600	26,270	30,946,500
1900	1,191	7,457	8,882,000	14,869	17,709,200	3,147	3,748,600	25,474	30,339,800
1901	899	8,641	7,768,600	15,309	13,763,000	3,169	2,849,100	27,119	24,380,700
1902	1,461	8,992	13,138,300	15,199	22,207,000	3,364	4,915,900	27,557	40,261,200
1903	1,399	8,003	11,196,600	15,845	22,167,700	3,834	5,364,700	27,683	38,729,000
1904	1,595	7,145	11,397,300	17,674	28,190,600	3,635	5,798,200	28,454	45,386,100
1905	1,902	9,475	18,022,200	19,795	37,651,200	2,439	4,639,400	31,709	60,312,800
1906	1,901	10,150	19,296,800	17,565	33,392,000	2,113	4,018,600	29,830	56,707,400
1907	1,674	11,256	18,843,500	12,966	21,706,600	2,271	3,801,900	26,494	44,352,000
1908	1,505	11,936	17,964,400	14,881	22,397,100	4,164	6,268,000	30,983	46,629,500
1909	1,367	10,952	14,972,400	12,188	16,661,100	2,787	3,810,400	25,928	35,443,900
1910	1,361	11,213	15,261,110	17,940	24,417,270	3,123	4,250,800	32,277	43,929,180
1911	987	9,467	9,344,250	25,679	25,346,000	4,034	3,982,100	39,181	38,672,350
1912	1,172	10,005	11,726,400	21,630	25,351,200	4,072	4,773,400	35,709	41,851,000
1913	1,008	9,248	9,322,264	16,328	16,459,116	2,935	2,959,419	28,512	28,740,799
1914	941	6,602	6,213,312	19,230	18,095,059	1,344	1,265,314	27,177	25,573,685

[a] Data not available for 1892.

Referring to the table showing the results of line fishing on Georges Bank, South Channel, and Nantucket Shoals, a different

condition is apparent. There the total catch per trip was smaller than in any year since 1908, excepting 1909; the catch of cod was the lowest recorded; more haddock were caught than in any year, excepting 1905, 1911, and 1912; and fewer hake were taken than in any year since 1891.

An examination of the following table and diagram, exhibiting the catch of the otter trawls, shows that the catch per trip of the gadoid fishes as a whole in 1914 was about equal to that of 1913 and lower than for any other year, excepting 1908 and 1909. Fewer cod were taken in 1914 than in any year, excepting 1910; fewer haddock than in three of the preceding six years.

QUANTITIES OF COD, HADDOCK, AND HAKE TAKEN BY OTTER TRAWLERS FROM GEORGES BANK AND SOUTH CHANNEL, 1908 TO 1914, INCLUSIVE.

Year.	Number of trips.	Cod.		Haddock.		Hake.		All kinds.	
		Per trip.	Total.	Per trip.	Total.	Per trip.	Total.	Per trip.	Total.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1908	44	4,767	209,800	35,045	1,542,000	1,059	46,600	40,872	1,798,400
1909	47	3,400	159,800	36,574	1,719,000	1,582	74,400	41,557	1,953,200
1910	59	2,133	125,850	47,033	2,775,000	789	46,600	49,956	2,947,450
1911	178	3,171	564,500	41,388	7,367,100	852	151,700	45,411	8,083,300
1912	295	6,620	1,952,950	43,954	12,966,700	355	105,500	50,932	15,025,150
1913	326	5,115	1,667,806	38,309	12,488,992	642	209,485	44,068	14,366,283
1914	387	2,970	1,149,595	39,750	15,383,550	670	259,913	43,392	16,793,058

There is ample evidence, therefore, that the catch of the principal food fishes on the banks frequented by the otter trawlers was considerably smaller in 1913 than for several years preceding, while on the banks on which there is little or no trawling there was a material increase, the catch on all banks combined being slightly above the average for the past six years. If the investigations had been made in 1911 or 1912, the statistical evidence would have tended to show an increase rather than a decrease during the same period in the average catch of fish by both otter trawls and lines on Georges Bank and South Channel.

In 1914, as compared with 1913, both liners and trawlers made smaller catches of cod per trip to Georges Bank, South Channel, and Nantucket Shoals and larger catches of haddock. On the other hand, the trips to all other banks yielded a smaller average catch of haddock and a larger catch of cod. If this can be held to mean anything, it is that during 1914 there were more haddock and fewer cod on the banks frequented by the trawlers and that the data indicate that there was merely a shifting of the schools of these fish from one region to another, the average on all banks combined remaining practically uniform.

The foregoing applies to that period only during which the steam trawlers have been a factor in the fishery, but the tables

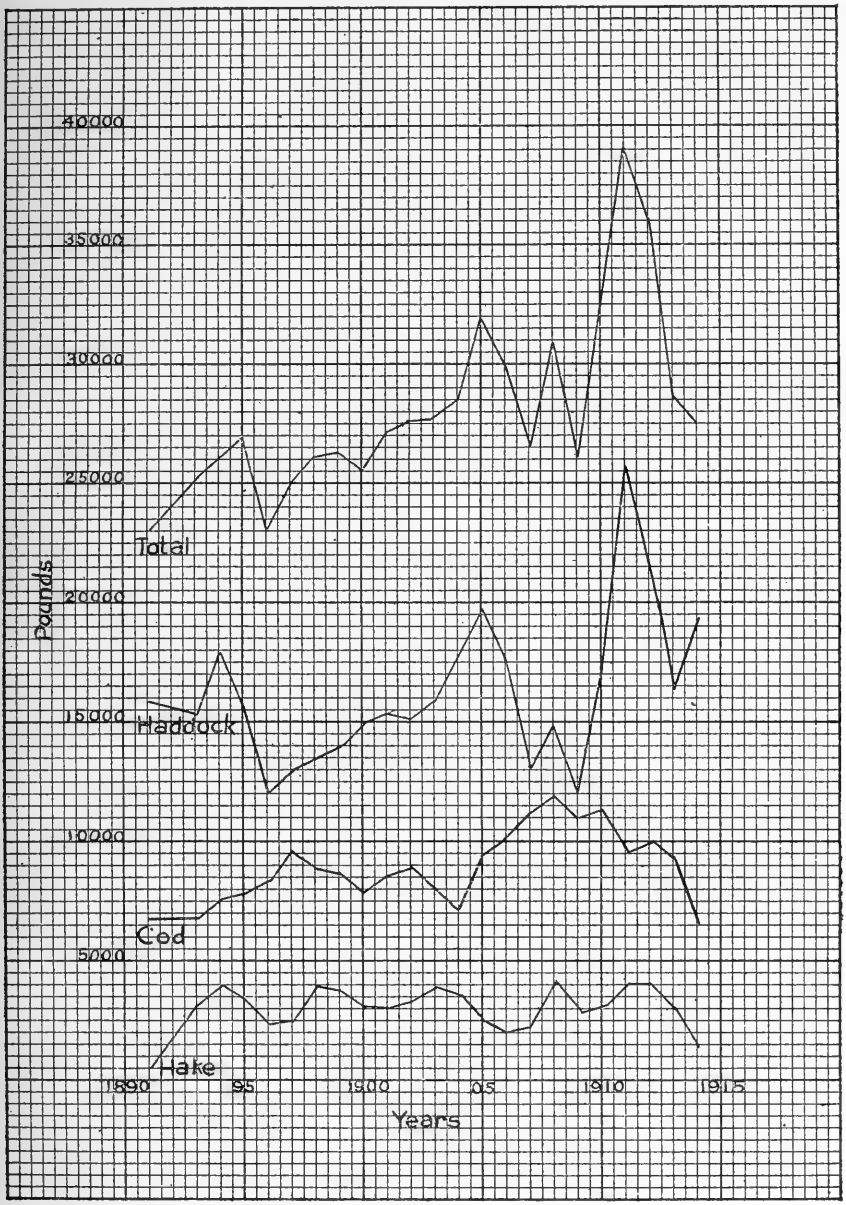
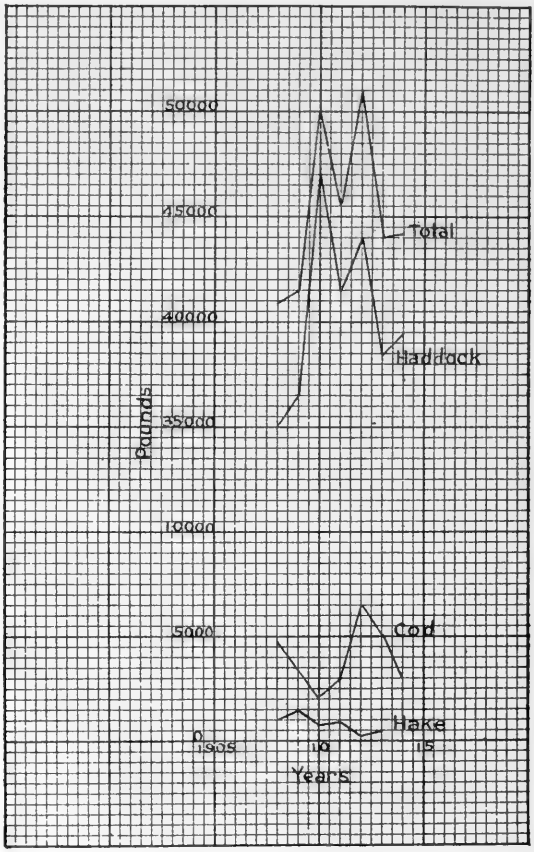


Diagram showing catch per trip by American line vessels fishing on Georges Bank, South Channel, and Nantucket Shoals.

and diagrams of the line-fishery catches supply almost complete data back to 1891. Considering this longer period, it will be seen that

the average catch per trip fell rather sharply from 1891 to about 1896 to 1897, but that since those years there has been a net increase both on the banks fished by the steam trawlers and on those which are rarely or never so fished. The sharpest fluctuations, however, are shown on the banks and during the period covered by the otter-trawl fishery. On Georges Bank, South Channel, and



Catch per trip by otter trawlers fishing principally on Georges Bank and South Channel.

Nantucket Shoals, the heaviest catch of haddock ever made as well as the lowest since 1896 occurred within this period, but the lowest catches per trip were when but one steam trawler was operating, and the largest and next to the largest came after the fleet had been considerably augmented.

After this report had been nearly completed, it was represented to the committee that during the year 1914 the fishery on Georges Bank, particularly for haddock, had been very unsatisfactory and that the line fisherman had practically ceased to resort to these grounds on that account. To test this allegation, the following

tables and the diagrams based on them have been prepared, showing the total annual catches and the average catches per trip of Gloucester vessels for a period of years. Gloucester alone was considered because all vessels from that port are liners, while the Boston fleet comprises the otter trawlers, which have gradually increased in numbers and have made it more difficult, therefore, to present valid comparisons between the several years.

QUANTITIES OF COD, HADDOCK, AND HAKE TAKEN BY GLOUCESTER LINE FISHERMEN ON GEORGES BANK, 1905 TO 1914, INCLUSIVE.

Year.	Number of trips.	Cod.		Haddock.		Hake.		All kinds.	
		Per trip.	Total.	Per trip.	Total.	Per trip.	Total.	Per trip.	Total.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1905	478	11,410	5,451,071	11,720	5,602,212	790	337,804	23,921	11,391,087
1906	418	15,215	6,359,900	21,377	8,935,735	1,495	625,091	38,088	15,920,726
1907	361	17,135	6,185,881	8,994	3,246,682	1,232	444,616	27,361	9,877,179
1908	316	22,930	7,246,011	11,860	3,747,820	646	203,998	35,436	11,197,829
1909	207	23,940	4,955,585	4,758	984,830	343	70,930	29,040	6,011,349
1910	187	28,516	5,332,487	8,255	1,543,775	441	82,493	37,212	6,958,755
1911	211	18,909	3,989,879	8,591	1,812,803	1,074	226,638	23,836	5,029,320
1912	268	20,306	5,441,802	12,606	3,378,439	610	163,607	33,522	8,983,848
1913	181	21,927	3,968,716	14,614	2,645,060	194	35,143	36,734	6,648,919
1914	123	19,679	2,420,597	21,305	2,620,525	552	67,919	41,536	5,109,041

From the tables and diagrams several facts appear. In the first place, since 1905 there has been a general large and fairly continuous decrease in the combined catch of the principal species and of the cod taken on Georges Bank by Gloucester vessels using lines. In the case of the haddock there was an enormous decrease from 1905 to 1909, but since then there has been a general increase in the total quantity landed at Gloucester.

Synchronously with these developments, there has been a heavy decrease in the number of trips, and this decrease was numerically greatest prior to 1909, when there was but one steam trawler in service. The falling off in the totals was, therefore, to some extent due to a reduction of fishing activity by the Gloucester vessels, and to eliminate this variable we have reduced the catch to a basis of quantity per trip and have found that the catch per trip of cod, haddock, and hake combined was greater in 1914 than in any year since 1905 at least and of haddock was about equal to that of 1906 and much greater than for any other year of the period considered. The catch of cod per trip was greater in 1914 than during four of the preceding nine years. The average catch per trip of cod and haddock each, and of these two combined with the hake, was greater for the five years 1910 to 1914, inclusive, than it was for the preceding five-year period.

We find, therefore, that there is no statistical support for the claim that the haddock, or any other demersal fish on Georges, has

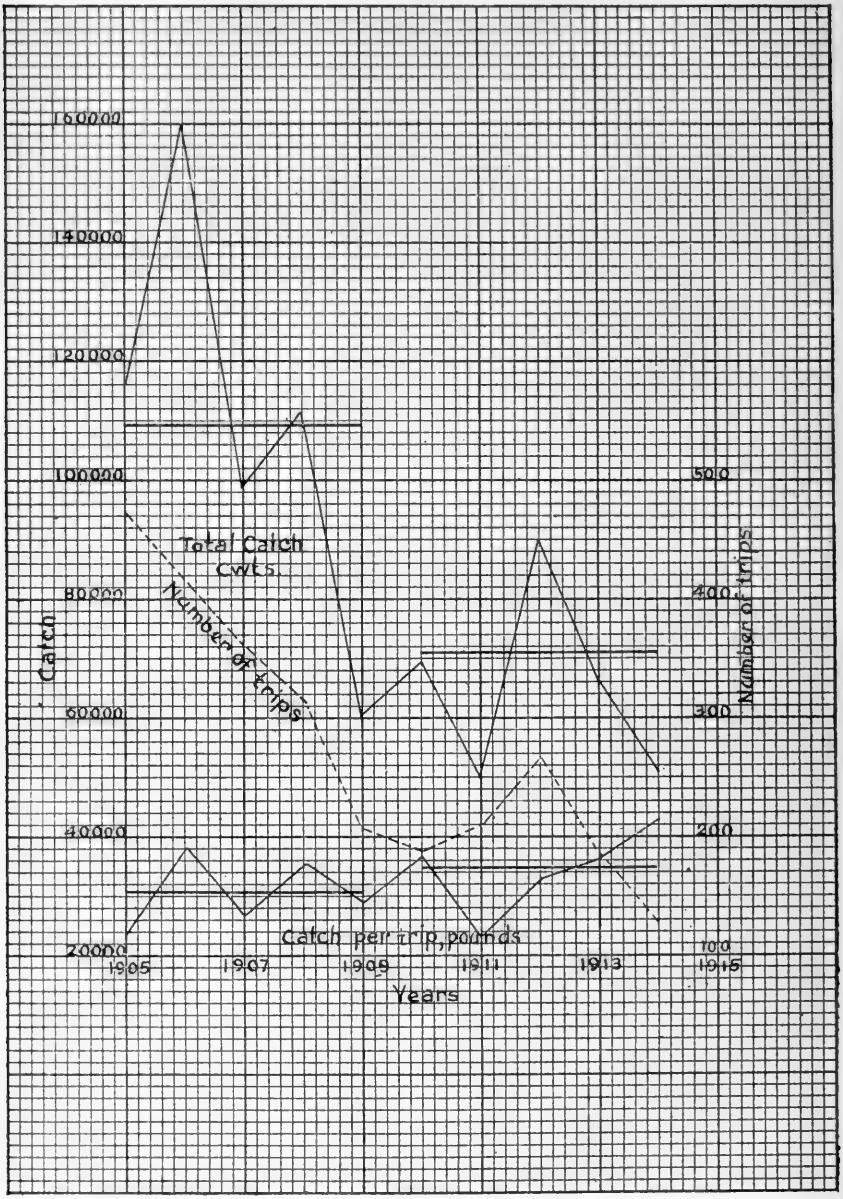


Diagram showing the total combined catch of cod, haddock, and hake, in hundredweights, average catch per trip in pounds, and number of trips made by Gloucester line fishermen on Georges Bank. The heavy horizontal lines show the average catch for five-year periods.

shown signs of overfishing since the first use of the steam trawler in 1905.

The increase in the catch of haddock per voyage of liners in 1914 can not be ascribed to an increased catch of scrod, for very few of the latter were taken, and the data show that very few are taken by liners even when the small fish are present in large numbers and are taken by the trawlers on the same ground. An examination of the

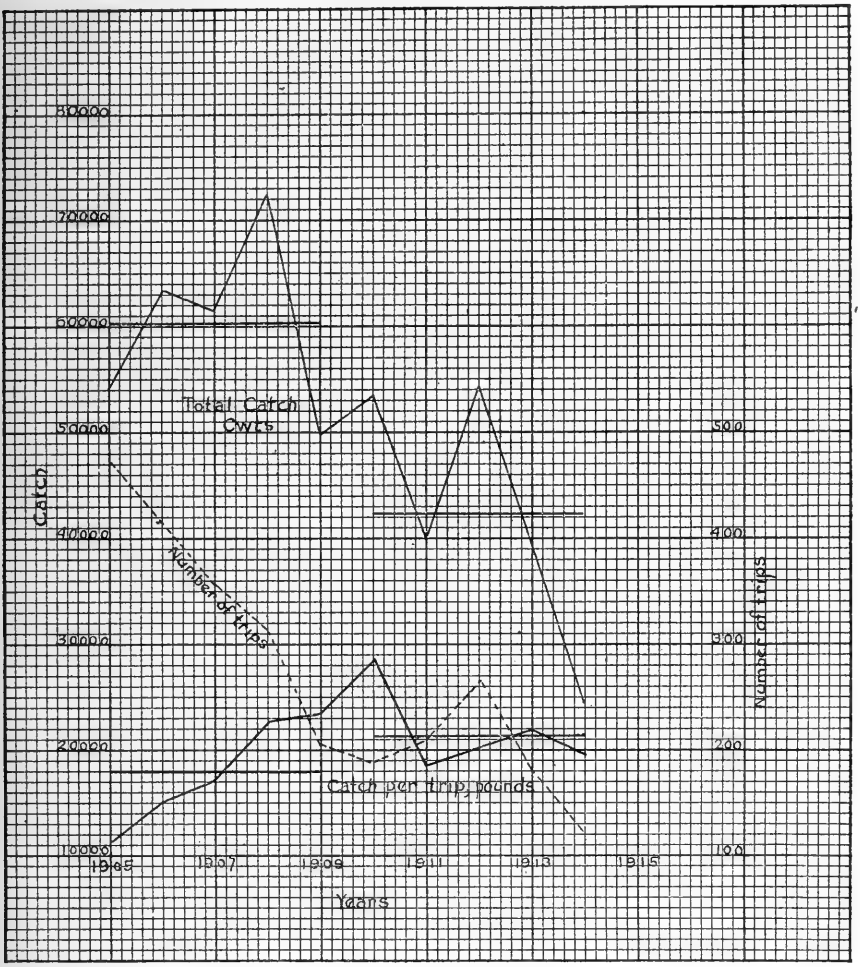


Diagram showing the total catch of cod in hundredweights, average catch per trip in pounds, and number of trips made by Gloucester line fishermen on Georges Bank. The heavy horizontal lines show the average catch for five-year periods.

monthly returns of this fishery shows that about 80 per cent of the haddock were taken in August and September, when the average per trip was nearly 40,000 pounds, as compared with an average of nearly 21,000 pounds for the year. The average for the remaining months was therefore comparatively low, and this doubtless has

given rise to the opinion of the fishermen that the fishery has been a failure, a view in which we can not concur. The total yield for the year is the true criterion. It may be noted that the heaviest

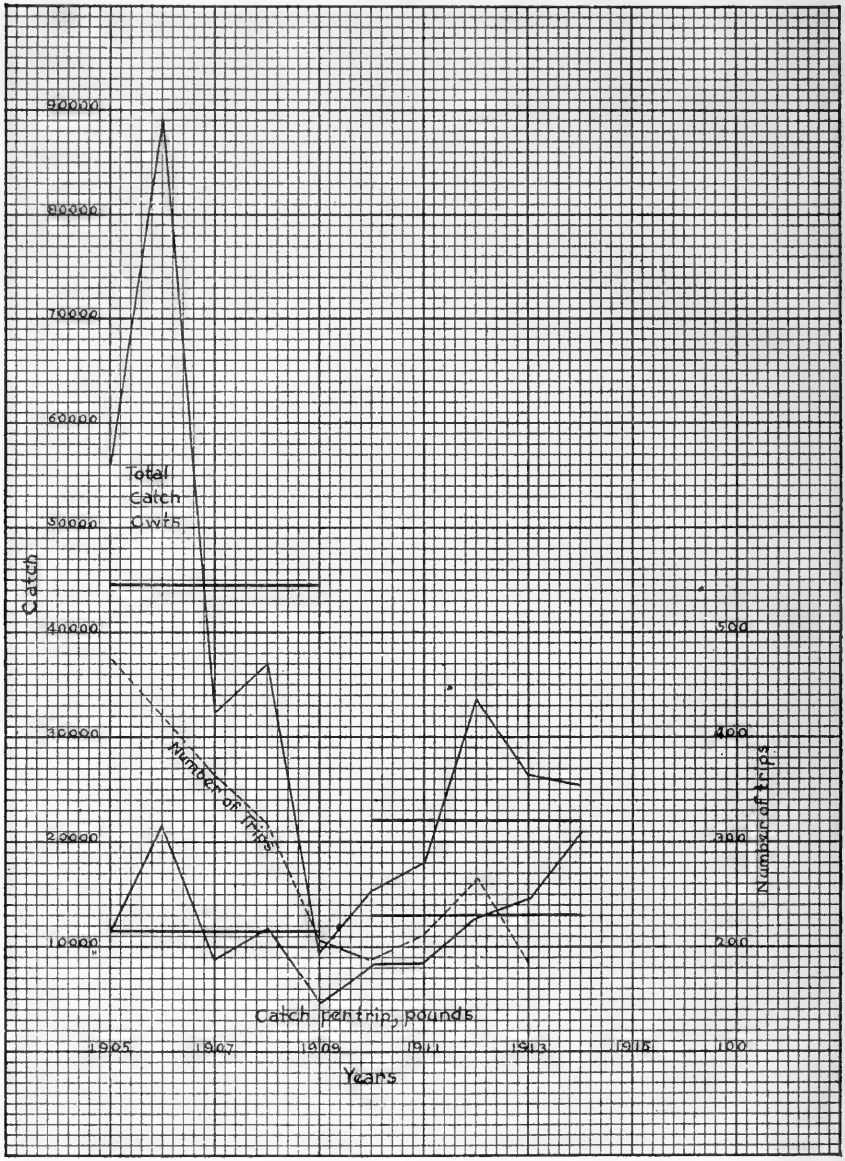


Diagram showing the total catch of haddock in hundredweights, average catch per trip in pounds, and number of trips made by Gloucester line fishermen on Georges Bank. The heavy horizontal lines show the average catch for five-year periods.

catch of the Boston fleet was made in January, February, and March, when Gloucester vessels made a monthly average of four trips to

Georges, as compared with an average of over 12 trips per month for the rest of the year.

Considering all of the data available respecting the supply of fish and particularly the haddock, the species most conspicuous in the catch of the otter trawlers, we can see no evidence of the depletion of the supply on the fishing grounds frequented by the otter trawlers. The average catch per trip shows no diminution from that made prior to the introduction of the steam trawlers.

DENUDATION OF THE BOTTOM BY OTTER TRAWLERS.

One of the most vigorously urged objections to the use of the otter trawl is that it tears loose, dislodges, crushes, and destroys the marine animal and vegetable growths which in places cover the bottom on the fishing banks. It is upon these sessile or attached organisms and the animals of many kinds to which they give harbor that the bottom fishes feed, and if it can be shown that any method of fishing or any practice of the fisheries denudes the bottom of any considerable proportion of these growths, it would establish abundant reason for regarding such fishery or practice as inimical to the productiveness of the banks.

The attached animals on the banks consist generally of sponges; hydroids and bryozoans, collectively called "sea moss" by the fishermen; ascidians, known as "lemons" and "strawberries"; sea anemones; mussels and other mollusks; burrowing and tube-building worms ("macaroni"); barnacles, etc. With the exception of many of the worms which burrow in sand or mud, the sessile forms are attached to rocks, pebbles, and shells, or to one another. Finding shelter among these or lying on the bottom are various species of crabs, shrimps, and other crustaceans; scallops, clams, and other bivalve mollusks; a variety of gasteropods or snail-like mollusks; many starfishes and brittle stars; sea urchins; sea cucumbers or "pumpkins"; worms; and fishes of various kinds, all preying or being preyed upon and in complex and intimate relation to one another generally. There are many minute animals and plants on the bottom and on the bottom growths or in the overlying water. Of these the microscopic plants are highly important, as they, with the seaweeds, are the fundamental source of food, direct or indirect, of all marine animals. Some of the fishes feed directly on these organisms, while others feed on animals which either consume them directly or at some more or less proximate stage find them in the chain of elaboration of their food supply.

The immediately important commercial fishes taken by the line trawlers are haddock, cod, and, to a less degree, hake. The same market fish with the addition of the "sole" are taken by the otter

trawlers. Both methods of fishing catch a few halibut and certain edible fishes which are not marketed. The haddock and the cod are the principal species sought, and were it not for these the bank fisheries would not exist under present economic conditions.

Both of these fish are bottom feeders, and while they feed to some extent on young or small fishes, their diet consists principally of invertebrates such as constitute the bottom fauna of the banks. They all sometimes contain pieces of herring and similar fishes, but there is good reason to believe that in most cases these are baits taken from the lines. Most of the food consists of echinoderms (starfishes, brittle stars, sea urchins, and sea cucumbers; lamellibranchs (scallops, mussels, and other bivalves); gasteropods (various snail-like mollusks); crustaceans (crabs and shrimps); and annelids (worms). Although these fishes spawn on some of the banks, they resort to them primarily for food; and there is no doubt that if the bottom growth were destroyed the productiveness of the fishing banks would be seriously impaired if not destroyed, and it is therefore important to the present inquiry that the methods of fishing now pursued should be considered in relation to their effects on the denudation of the bottom.

In this respect the trawl-line fishery is innocuous and need not be discussed, but the otter trawl operates in such manner as to raise a valid assumption against it and to demand a critical examination of its effects. As the otter trawl, as a whole, sweeps over an area of about 80 acres at each haul and many square miles in the course of a year's fishing, the assumption has been that its effects on the bottom growths of necessity must be disastrous; and the observers on the steamers were instructed particularly to note the quantity and character of the bottom materials brought up. Most of the sand, broken shells, and other fine material not bound together by worm tubes, etc., undoubtedly would wash through the mesh and would not figure in the load landed on deck, but a large part of the bottom growth, which, and not the bottom itself, is the important factor in the present inquiry, would come up in the trawl.

Much of the data submitted by the observers are too vague for quantitative consideration, but one man definitely states the quantities in bushels in his monthly analysis of the results of his observations on each bank. From his returns it is deduced that the average quantity of scallops, clams, shells, sponges, starfishes, and bottom material generally, varied with the month and the locality, from a small fraction of a bushel to 4.7 bushels per haul, the latter being the average of 26 hauls made in South Channel in August, 1913.

A simple computation shows that this maximum represents a film 0.00024 inch in thickness spread over the area swept by the trawl, or, to state the case in another way, a little pile of material 1 foot

square and 9 inches high on each acre traversed. This means either that a small proportion of the existing bottom material was captured by the net, which is probable, or that there was very little material to take. In either case the result to the fishery is trivial and negligible, as the whole quantity, shells and all, if eaten by the marketable haddock and cod alone taken in the same hauls would constitute a morsel of but about 2½ cubic inches for each—a very small meal, indeed—and leave nothing for the many other fishes taken at the same time.

But, the evidence shows, this material was not destroyed but thrown overboard when the decks were cleared after each haul, the uninjured organisms in large part to carry on their lives as before, and the dead shells to lie again on the bottom and serve as places for attachment for other growths. Any crushed scallops, mussels, etc., undoubtedly would be eaten by fishes or by animals on which the fishes feed, for no dead organic matter is permitted to lie long unutilized on the floor of the sea. Fragments of sponges would each begin to grow into a new sponge, and mutilated starfishes would soon reproduce the injured or lost parts, if they did not fall prey to the fishes in the meantime. This modicum of captured and liberated material would therefore be little if any diverted from the function which it would have discharged if it had remained unmolested on the bottom. It is claimed, however, that but part of the damage wrought to the bottom by the trawls is represented by the material brought up in the nets, greater quantities of the bottom organisms being torn loose, crushed, and mutilated. To the extent that this may be true, the preceding remarks on the utilization of the detached and injured organisms also apply. It is, of course, impossible to observe the action of trawls operated in depths as great as are found in the bank fisheries, but by an examination of the catch, the method of operating the apparatus, and comparison with the known effects of similar appliances, conclusions of some value may be deduced.

There are three parts of the otter trawl which scrape the bottom: The boards, the foot line, and the net itself. The boards each weigh about 1,500 pounds in the air or about 900 pounds in the water, and as they are 12 feet long and 2½ inches thick they bear on the bottom with a pressure of a little less than 3 pounds to the square inch. This is a little less than the standing pressure of an average man. When the net is fishing, the otter boards are set with the short sides vertical and their long sides at an angle of about 20 degrees or less to the direction of motion, and as they are 12 feet long each scrapes a strip about 4½ feet wide. As the average haul of an otter trawl is about 6 miles, the two boards scrape on each haul a surface of about 6½ acres. An average of about 35 hauls was made on each trip observed, and on this basis it is computed

that on the 326 trips made by the steam trawlers in 1913 the boards alone scraped about 115 square miles of the bottom, provided they were in constant contact.

The footline or ground rope forms the front border of that part of the net lying on the bottom. It stretches in a curve between the otter boards, is about 140 feet long, and 3½ to 4 inches in diameter. It is composed of a core of steel wire rope about 1 inch in diameter, heavily served with marlin and rope partly to protect the wire from chafing, but principally to prevent undue cutting into the bottom. The ground rope weighs about 800 pounds in the air, but as rope is but little heavier than water and the wire weighs not over 150 or 160 pounds, it is certain that when at rest it does not exert a pressure in excess of 2 pounds per linear foot.

The ground rope sweeps over a strip about 100 feet wide, and using the same data employed in the discussion of the otter boards this would cover an area of about 73 acres per haul and about 1,300 square miles for all hauls made by the steam trawlers in 1913.

The net with its chafing gear, a device of old netting to minimize abrasion on the bottom, weighs about 800 pounds in air, but very little in water. As fish weigh but little more than water, the catch adds nothing to the pressure of the net on the bottom unless it includes stones, sand, shells, and other heavy materials. The net, being attached to and following the ground rope, sweeps over the same area.

The otter boards, by virtue of their inclined position to the line of draft through the water, act, when resting on the bottom, like the scraper of a road machine, such material as they dislodge or tear loose passing backward and inward toward the net. As the purpose of the boards is to spread the net laterally, no useful purpose is served by permitting them to plow deeply, and the ideal practice is to have them skim over the bottom as lightly as possible. The drag of the towing warps, inclining upward toward the vessel, tends to lift the boards, especially at the forward ends, and this tendency increases with the speed at which they are towed and, at any given depth, inversely with the length of warp paid out. With the speed too great or the warp too short, the boards and with them the net may be lifted quite clear of the bottom. A slight lifting of the boards is permissible and perhaps desirable, but if the ground rope raises materially, the efficiency of the net is impaired.

There are two instruments employed in fisheries in other parts of the world for taking bottom growths, the effects of which are comparatively well known, and a consideration of these, by analogy, may be of some assistance in the formulation of an opinion as to the effects of the otter trawl. One of these is the dredge extensively employed in the oyster fishery. This consists of a short chain bag

or net, attached to a rectangular steel frame, about 4 feet on its long sides. The average weight of these dredges is about 150 pounds, and the long sides of the frames are provided with 15 or more long, steel teeth which dig into the bottom as the instrument is dragged over the beds. They are designed especially to tear the oysters from the bed, and incidentally they bring up sponges, starfishes, mussels, and other bottom organisms.

It is estimated on good data that in Maryland the dredging vessels in the course of the season's work cover with their dredges an area equal to about three times that of the oyster beds, or, in other words, an average acre or square mile is scraped three times in the course of the year. These beds have been intensively dredged annually for many years, and while some of them have been depleted, they are still producing large quantities of oysters wherever care has been exercised to return to the beds all shells and small oysters. Where the beds have been depleted it is in nearly every case due to neglect to comply with the requirements of the law in this respect.

The other implement to which reference was made in a preceding paragraph is the gaugava, a peculiar type of dredge trawl used in the Mediterranean sponge fisheries. It consists of a short bag net of heavy twine attached to a rectangular frame about 35 feet long and 2 feet high. The lower side and about half of the two ends is composed of an iron bar 2½ to 3 inches in diameter weighing about 600 or 700 pounds, and the top of the frame is a wooden bar 5 or 6 inches in diameter. This implement is towed at a speed of about 1 to 1½ miles per hour, and the length of the towing warp is so adjusted that the iron bar scours the bottom without burrowing. The purpose of the gaugava is to tear commercial sponges from their firm attachments to the bottom and incidentally it brings up all other bottom growths. It is undoubtedly the most destructive method of sponge fishing, as it tears from their attachment many commercial sponges too small for the market which would be valuable if permitted to become a year or two older. Yet 150 vessels are using this appliance on the coast of Tunisia, and while the beds have been depleted to some extent and require occasional periods of recuperation, they are after many years still profitably productive. Now both the oyster dredge and the gaugava are designed for tearing up and capturing the bottom growth, they are employed in a way to accomplish that purpose, and a large part of the material captured is not returned to the water. Each of them is much heavier than the ground rope of the otter trawl, the dredge weighing in water about 30 to 35 pounds to the linear foot, the gaugava about 15 pounds, and the footrope of the trawl less than 2 pounds.

The footrope of the trawl is of larger diameter than the frames of the other two implements, and, moreover, it is covered with rope, a cushioning material, while the others are bare steel. It is evident that if it were towed at the same speed as the oyster dredge and the gaugava it would do much less damage owing to its comparatively small weight per foot, but it is dragged at a much higher speed than the oyster dredge and at about three times the speed of the gaugava, which it more closely resembles. With the same length of warp, dredges and trawls touch the bottom more lightly the higher the speed at which they are towed, and at the same speed the lighter and more bulky gear lifts more freely than the heavier and more compact. That the otter trawl catches an insigificant quantity of bottom material as compared with the oyster dredge and the gaugava has been shown by direct observation, and that it does a negligible amount of damage not observable is clear from a comparison of the construction and methods of operation of the three types of apparatus and a consideration of the fact that years of intensive operation of the dredge and gaugava have by no means destroyed, although they have to some extent depleted, the beds on which they work, especially when recklessly used. The only parts of the otter trawl which have sufficient weight to effectively scrape the bottom of its attached organisms are the boards, and they cover but about 10 per cent of the sweep of the net and undoubtedly are much of the time largely and part of the time wholly supported by the draft of the towing warps.

It is believed, therefore, that denudation of the bottom is not a momentous factor in any injury which may be wrought to the fisheries by the otter trawls.

DESTRUCTION OF SPAWN BY OTTER TRAWLERS.

The allegation sometimes made that the otter trawl destroys the spawn of food fishes can be dismissed with a simple negation. The eggs of all of the important food fishes of the New England coast and the banks, except the herring, are pelagic; that is, they float at or near the surface.

The only destruction of spawn is that involved in taking spawning fish, and such fish are also taken on hand lines on Georges Bank at least and by nets along the coast.

INTERFERENCE OF THE OTTER TRAWL WITH OTHER FISHERIES.

The observers on the vessels were instructed to make note of all cases in which lines or other fishing gear were destroyed or interfered with by the steam trawlers. Very few cases of such destruction or interference were noted.

Mr. Walter H. Rich, who served from June to November, inclusive, most of the time on steam trawlers, but who made a number of

trips on trawl liners, says: "The captains of all steamers use care in avoiding the trawls of the sail fleet when possible, often taking up the net before a haul was finished when they approached a line of dories engaged in fishing. On two occasions only did the writer see the gear of the line trawlers fouled in the net, both in thick fog, and in each case the line was cut and knotted together and put overside with no apparent damage to the gear."

Mr. John N. Burrows, who made 10 trips on trawl liners between June 24 and December 29, most of them on banks fished by the otter trawlers, and served on otter trawlers from April to December, reports no cases of interference; and Mr. Thomas M. Douthart, who made observations on the steamers from January 17 to May 1 and one trip on a schooner, says: "The trawlers make particular effort to keep clear of other fishing gear."

The testimony of the other observers was similar, and there is no doubt that during the year 1913 the damage to trawl lines was negligible, and what little did occur was unintentional.

GENERAL ECONOMIC AND SOCIOLOGICAL QUESTIONS.

The general economic and social effects of a change in the character of the bank fisheries, due to the introduction of otter trawling, are matters which we do not regard as within our province to discuss in detail. We believe that the unregulated use of otter trawls will inevitably result in the practical displacement of the less efficient line fishery, and that this will induce a change in the character of the men manning the fleet, as the substitution of steam for sail power has changed the type of crews in the merchant marine and in the Navy. There is also the probability, in fact almost the certainty, that the change would result in a reduction in the number of individual vessel owners and the concentration of ownership of fishing craft in the hands of a comparatively small number of firms and corporations. Whether or not these changes be desirable is a matter to be judged by the same criteria governing opinion respecting similar phenomena affecting other industries.

The regulation of the fisheries is predicated on the necessity of providing and conserving a common food supply, and the special protection which it receives at the hands of the Government is to that end. The consideration of broad subjects of social welfare should be divorced from special application, and we do not regard them as germane or peculiar to the investigation with which we are charged.

It should be indicated, however, that the changes enumerated would have, in addition to a great reduction in the number of men employed on the fishing fleet, certain collateral results of wide reach-

ing effect. The men employed in catching bait[a] would lose their calling; the cold-storage plants preserving food fish and bait at various places on the coasts would lose a material part of their business; shipbuilders, manufacturers, and artisans employed in supplying the sailing fleet would find their business destroyed or seriously curtailed; and a wide economic readjustment would be obligatory in many communities.

On the other hand, the general substitution of otter trawls for lines will result in the stimulation of steel shipbuilding and related industries and furnish additional markets for coal, oil, and engineering supplies. The trawl nets are now purchased in Great Britain. A canning establishment which recently began utilizing the bank fishes now depends largely on the otter trawls for its raw material. Whether its continuance is contingent on the permanence of the otter-trawl fishery is not known to us.

EFFECTS OF OTTER TRAWLING ON THE PRICE OF FISH.

An important element in the case of lines versus otter trawls is whether the introduction of the admittedly more efficient apparatus will result in a reduction in the cost of fish. The consumer, who is the factor of paramount economic importance, rarely is heard when industrial legislation is being considered, and for that reason we have departed from our avowed purpose to refrain from discussion of general economic matters not peculiar to the fisheries and have endeavored to arrive at an understanding as to the probable effect of otter trawls on the trend of prices. For this purpose we have examined the prices at which the important species of the cod family and fresh fish as a whole have sold in Boston during each year since 1898. These data are shown in the following table and in the diagram based thereon:

PRICES RECEIVED BY FISHERMEN FOR FRESH FISH LANDED AT BOSTON, 1898 TO 1914, INCLUSIVE.

Year.	Cents per pound.				Year.	Cents per pound.			
	Cod.	Haddock.	Hake.	All fish.[b]		Cod.	Haddock.	Hake.	All fish.[b]
1898	2.1	1.7	0.9	1.8	1907	2.9	2.9	1.9	2.8
1899	2.2	2.2	1.1	2.1	1908	2.7	2.5	1.7	2.5
1900	2.2	2.0	1.4	2.2	1909	2.8	2.5	1.5	2.5
1901	2.7	2.4	1.5	2.6	1910	3.0	2.5	1.6	2.6
1902	2.4	2.2	1.7	2.4	1911	3.2	2.3	2.0	2.7
1903	2.9	2.2	1.6	2.4	1912	3.3	2.2	1.8	2.6
1904	3.0	2.3	1.3	2.5	1913	3.4	2.9	2.3	3.1
1905	2.6	2.1	1.7	2.3	1914	2.7	2.5	2.2	2.8
1906	2.4	2.0	1.9	2.2					

[a] Some estimates indicate that 50,000,000 pounds of bait, caught by boat and trap fishermen, are used in the line fisheries conducted by New England bank vessels.
[b] Excepting mackerel. Herring could not be excluded for lack of data.

The table, and particularly the diagram plotted from it, shows a consistent, though fluctuating, increase during the 16 years ended in 1913 in the prices of each of the species separately enumerated, as well as in the prices of fresh fish as a whole. At the end of that period all prices except for haddock were higher than ever, although for 1912 and the five years preceding there had been but little or no general price increase, the cod alone excepted. In 1914, however, there was a noteworthy drop in the price of cod, which was reflected in the average price for all fish, while haddock and hake likewise showed a decline.

To determine whether the recent comparative maintenance of prices was due to the larger number of small fishes landed by the

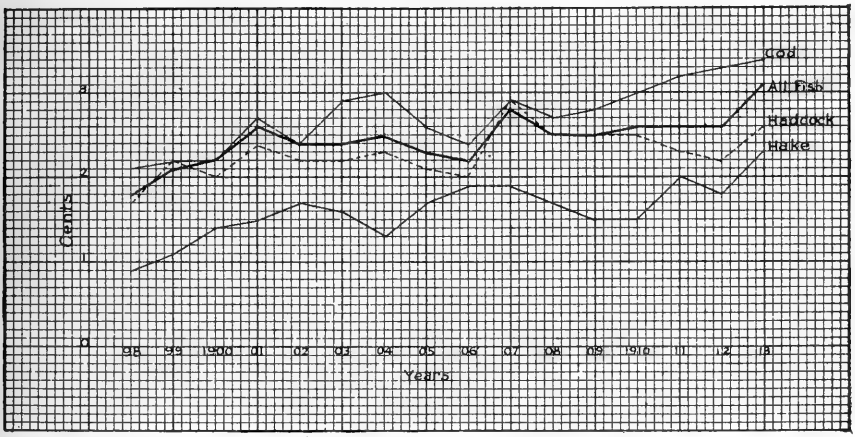


Diagram showing average prices per pound received by fishermen for certain fishes landed in Boston.

steam trawlers, the following table has been prepared. It should be explained, however, that the table immediately preceding and the one following, except for the year 1914, were derived from two separate sets of statistics and are, therefore, not exactly comparable, but each by itself indicates the general tendency of the prices. The first table was computed from the statistical bulletins of the Bureau of Fisheries, in which the trade sizes of cod, haddock, and hake were not available prior to 1914. The second table was taken from the books of the New England Fish Exchange, which provided data regarding the sizes as far back as 1909 only.

AVERAGE PRICES OF FRESH BOTTOM OR BANK FISHES SOLD AT THE NEW ENGLAND FISH EXCHANGE, BOSTON, 1909 TO 1914, INCLUSIVE.

Species and sizes of fish.	Cents per pound.					
	1909	1910	1911	1912	1913	1914
Cod:						
Large	3.3	3.5	3.8	3.9	4.6	4.1
Market	2.1	2.4	2.7	2.4	2.5	2.1
Scrod	1.8	2.4	2.1	1.8	1.7	1.4
Haddock:						
Large	2.4	2.5	2.2	2.1	2.9	2.6
Scrod	1.7	2.0	1.9	1.5	2.1	1.7
Hake:						
Large	1.9	2.4	2.3	2.7	2.9	3.1
Small	1.2	1.6	1.5	1.3	1.6	1.7
Sole	2.3	2.4	1.9	2.0	2.9	3.6

It appears from this table that between 1909, when there was but one steam trawler fishing, and 1913, in the latter part of which 10 such vessels were employed, there was an increase in the prices of all sizes of the principal demersal fishes, with the exception of scrod cod. This increase manifested itself in all years excepting 1912, when there was the largest catch of which we have record, and the prices of haddock and scrod haddock fell below those of the preceding 4 or 5 years. The figures for 1914, however, show a fall in the prices for all sizes of cod and haddock and a rise in the prices for large and small hake and for "sole." It is deduced from a combination of the data presented by the two sets of tables that within the past few years the advance in the prices of cod and haddock as a whole has been slightly retarded by the large quantity of the smaller and cheaper fish brought in by the steam trawlers.

It must be stated, however, that the otter trawl has not been used for a sufficient length of time in American waters, nor has it attained sufficient importance as compared with the line fisheries to have much influence on the trend of prices, but a study of the conditions in Europe throws some light on the subject.

In England and Wales the otter trawl supplanted the beam trawl, to the practical exclusion of the latter, about 1898. Data dating from that time are available as showing the trend of prices of fish in the countries named, and these for several of the more important and characteristic species, and, combined, for all fish commonly taken in the trawls, are shown in the following table and diagram:

Average Prices of Fresh Fish Landed in England and Wales, 1898 to 1913, Inclusive.

Year.	Cents per pound.						
	Cod.	Haddock.	Hake.	Sole.	Lemon sole.	Plaice.	All fish.
1898	3.4	2.8	3.4	34.6	.....	5.9	3.4
1899	3.5	3.0	3.3	34.9	.....	5.9	3.5
1900	3.5	3.3	3.8	36.5	.....	5.8	3.7
1901	3.7	3.5	3.5	35.6	.....	5.3	3.6
1902	2.8	3.0	3.6	33.1	10.9	3.9	3.0
1903	2.9	2.4	3.2	31.9	11.9	4.6	3.0
1904	2.8	2.5	2.9	28.8	11.3	4.2	2.7
1905	3.1	3.0	3.2	28.5	11.1	4.5	3.1
1906	2.8	2.4	3.4	31.5	12.2	5.4	3.0
1907	3.0	2.5	3.3	33.6	12.1	4.7	2.7
1908	2.9	2.7	3.2	31.6	10.9	5.0	2.8
1909	2.1	2.6	3.1	31.8	9.6	4.2	2.6
1910	2.4	2.9	3.7	33.3	10.7	4.9	2.9
1911	2.4	2.9	3.7	31.6	10.9	4.9	2.7
1912	2.8	3.3	4.0	32.1	11.6	6.1	2.9
1913	3.1	4.1	5.1	33.7	12.2	7.0	3.0

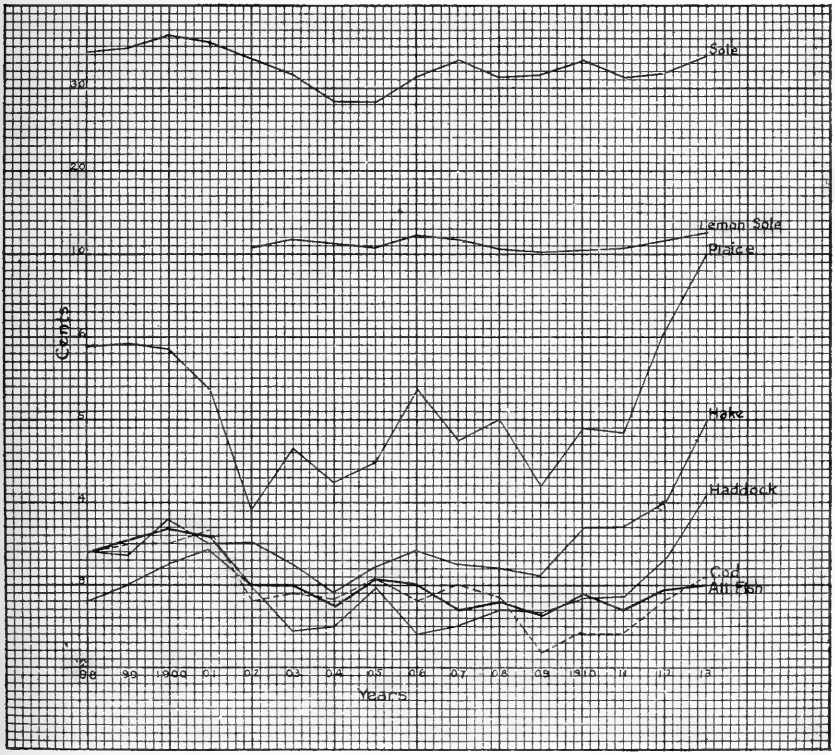


Diagram showing average prices of fresh fish per pound received by fishermen for certain fishes landed in England and Wales.

From 1898 to about 1900 or 1901 there was a slight increase in the average price, but henceforth to 1911 there was a distinct and consistent downward trend in all species excepting the hake, for

which there was a growing demand outrunning the supply. In 1912, as is graphically shown in the diagram, there was a sharp upward turn in the price of all of the cheaper fish and a slight rise in the more expensive kinds, and this tendency was accentuated in 1913. In the latter year, haddock, hake, and plaice were all considerably higher than in any year here recorded, lemon soles were higher than at any time since they have been separately listed, soles and cod were higher than since 1901, and demersal fish as a whole had returned in average price to the level of 1912.

Therefore, while the average prices of the most important species of demersal fishes have been, in general, lower since the otter trawl supplanted previous methods of fishing, they were in 1913, the latest year of which we have record, higher than in 1898, with the single exception of the cod; and in the case of the haddock, hake, and plaice, the increase has been large.

It should be noted, also, that with respect to the cod there has been a decrease in the proportion of the larger and more valuable sizes since 1903, at least, and a corresponding increase in the small ones. In the plaice, the large size has diminished proportionately to both the medium and small. In respect to these species, therefore, the increased marketings of the smaller and cheaper sizes has had a tendency to repress the upward trend of prices, which would have been more marked if the relations of the sizes in earlier years had been maintained.

In regard to the haddock, which is the other most important trawl-caught fish, the situation is peculiar. The statistics show a material increase in the proportion of large fish landed, a slight decrease in the medium size, and a considerable decrease in the proportion of small. As the total catch of the species has decreased, it is believed that the condition shown by the statistics has been brought about by the transfer of fish formerly rated as medium to the category of large, and of small fish to the medium class. That this may be true is indicated further by the fact that while small haddock brought but 28 per cent of the price of large ones in 1906, they brought 75 per cent in 1912 and 80 per cent in 1913. In later years, all three classes have more nearly approached parity in price, presumably because, to some extent, they were more nearly approaching parity in dimensions. It should be mentioned, however, that this evening up of the prices was doubtless due, in some degree, to the education of the public to consume smaller fish. Unfortunately, there have been no fixed or recorded standards of the sizes of fishes, and it is known that the standards vary as between the several ports and at the same port from time to time. In view of all considerations, however, we believe that the average size of all haddock taken has decreased, and that the prices would probably

be higher than they are if the former standard had been maintained.

To summarize, while the otter trawl in England and Wales reduced the cost of production of fish for a number of years after it became the predominant method of fishing, it did this to some extent by reducing the standard of sizes, and within the last two years prices have increased rapidly until they are higher than ever. To what extent the general increase in commodity prices has been responsible can not be determined.

It may be noted that the increase in the price of fish in 1912 and 1913 occurred in the face of the heaviest fisheries that Great Britain has ever known, in which, however, the species taken in the trawl fishery did not participate.

INSUFFICIENCY OF DATA.

While certain provisional deductions are drawn from the preceding analysis, the data are not regarded as sufficient to warrant an opinion respecting the effects of steam trawling on the fisheries. The period during which the American trawlers have operated has been too short, the trawlers engaged have been too few, and their catch, relatively to the catch by liners fishing on the same banks, has been too small to make it probable that they could have shown any drastic effect. Such fluctuations as have occurred during the time may have been merely the periodical changes common to all fisheries. For this reason it has been necessary to consider what is known of the fisery in the North Sea, the region in which it has reached its greatest development, and where it has been prosecuted for the longest time. The only data for a sufficiently long period available to the committee considering the subject are those contained in the Annual Reports on Sea Fisheries of England and Wales and the Annual Reports of the Fishery Board for Scotland. These two countries have four-fifths of the North Sea trawlers, catch over two-thirds of all fishes taken in the North Sea and over three-fourths of all demersal fishes landed from that region, and, therefore, if an analysis of the statistics develops any pronounced facts, they can be assumed, with some safety, to be applicable to the North Sea fisheries as a whole.

The statistical publications of The Permanent International Council for the Exploration of the Sea contain interesting detailed information respecting other countries in recent years, but as this can not well be correlated with the data from earlier periods it has not been used. Unfortunately, the same difficulty has been encountered in a measure in dealing with the English and Scotch statistics. The forms of the tables, the character of the data which they contain, the classification of the fishes, and the detail and particularity of the data have been changed from time to time. This has not only

entailed great labor in an effort to arrive at the facts, but has necessitated some lack of uniformity in the consideration of the several periods, and has also, taken in connection with modifications in the methods of the fishery, dictated the selection of the particular periods considered. If the data for the entire series of years had been presented in the form adopted since about 1906, many difficulties would have been removed, and the matter presented in this report would have been more explicit in some respects. While this report appears to consider and compare certain years only, largely for the reasons just explained, all English and Scotch reports since 1891 have been laboriously examined, and it is not believed that if other years were substituted there would be any material change in the apparent trend of the analysis.

MINOR AMERICAN TRAWLNET FISHERIES.

In considering the matter of the regulation of the otter-trawl fishery on the oceanic banks adjacent to the coast of New England, which is the prime purpose of this report, it is necessary to keep in view two minor fisheries prosecuted by the otter trawl or its equivalent concerning which there appears to be little or no complaint.

CAPE COD FLOUNDER FISHERY.

The first of these is the flounder fishery on the shores of Cape Cod. The fishery was established about 1895 or 1896, and 27 trawl nets were in use in 1898. In 1902 the number had increased to 65, and in 1908, the latest year for which we have information, there were 126; it is understood that the number has increased since then.

The vessels in the Cape Cod otter-trawl fleet, which is owned principally in Provincetown, Hyannis, and Falmouth, is composed of craft ranging from motor dories to auxiliary motor vessels of 25 to 30 tons. Beam trawls were formerly employed, but they have been practically supplanted by otter trawls measuring from 30 to 50 feet between the boards. The fishery is conducted in depths of 10 fathoms, more or less, and as it is confined to Cape Cod Bay and Nantucket Sound, it is within territorial waters and, therefore, within the jurisdiction of Massachusetts. Few fishes other than flounders are taken, the principal species being the winter flounder, locally known as the "black back," and the rusty dab, known to the fishermen by the name of "fluke" and "yellow tail." The present catch of these trawls is not known, but in 1898 they took 766,850 pounds, valued at $8,564; in 1902, 1,419,809 pounds, valued at $43,169; and in 1908, 2,893,000 pounds, yielding the fishermen $64,000. At Hyannis and Falmouth the trawl fishery is of very recent development.

Previous to 1908, from 6 to 12 small boats employing hand lines made an aggregate annual catch of 200 to 300 barrels. With the

introduction of beam trawls, more than 125 men have gone into the business in Hyannis and Falmouth, and in the season of 1910 and 1911 they caught and marketed 11,500 barrels (over 2,575,000 pounds) of winter flounder, receiving therefor the sum of $57,500.[a] As comparatively few of these fishes are taken by other methods, the otter trawl in this case has added to the food supply a fishery product not otherwise largely available.

SAN FRANCISCO PARANZELLA FISHERY.

This fishery was introduced from the Mediterranean many years ago and is prosecuted by Italian fishermen employed principally, if not entirely, by two San Francisco companies. In 1908 there were 20 of these nets in use at this port. The paranzella is essentially similar to an otter trawl, but the wings are kept extended not by otter boards but by warps or lines carried to tugs. Two vessels steering on parallel courses are required to operate a net. The tugs are about 85 feet long and of 30 tons net register, with an engine of about 150 horsepower and a crew of 11 men.

In 1908 the paranzella nets caught 4,722,000 pounds of fish valued at $87,000, of which 3,629,000 pounds valued at $68,000 were flounders and soles. No large numbers of fishes important to the line fisheries are taken. The fishing ground is a strip about 50 miles long and 5 miles wide lying about 12 miles seaward from the Golden Gate. There is practically no other fishing on this ground, and, therefore, the paranzella nets do not interfere with other methods of fishing. About 15 per cent of the fish brought up in the net are immature. The fishery is conducted beyond the limits of territorial jurisdiction.

DEMERSAL FISHERIES OF ENGLAND AND WALES.

INTRODUCTION.

In the preparation of this report every effort has been made to trace the history of the demersal fisheries of England and Wales, and especially of the North Sea, continuously from 1891 to the latest date for which data are available, but after careful consideration it has been found necessary to break the continuity of the discussion, because there appears no basis for harmonizing the possible analyses of the statistics prior to 1901 with those which can be made after 1903. In other words, one basis of comparison is possible between the several years of the earlier period and another between those of the later series, but none whatever can be made between 1901 and 1903, when there was an abrupt change in the manner in which the data were presented.

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[a] Report of the Commissioner of Fisheries, 1911, p. 50.

From 1891 to 1901 there are no data relating to the North Sea specifically, but there is material for the consideration of the fishery out of certain east coast ports from which the operations in the North Sea were so overwhelmingly predominant to those carried on in other regions from the same ports that no violence is done to the validity of the discussion by considering that the fishery was conducted in the North Sea alone. These ports were North Shields, Sunderland, Hartlepool, Scarborough, Yarmouth, Lowestoft, and Ramsgate. Grimsby, Hull, and Boston were concerned largely or predominantly in the fisheries in other regions than the North Sea, which would introduce an important error, and they are therefore eliminated from consideration. Furthermore, during the period from 1891 to 1901, while the whole number of vessels is stated in the reports, there is no specific designation of the numbers of the respective classes and types and the catch of each, and as the ratios of these to one another undoubtedly varied from year to year, and as the efficiencies of the different sorts and sizes of vessels and the kinds of fishes which they catch diverge widely no adequate measure of the intensity of the fisheries can be applied.

From 1903 onward the data presented in the reports are much more specific, the catch from the North Sea is definitely given, as are also the number of landings of the different sorts of vessels, the catch of each, and, especially in the later years, the definite character of that catch.

With the reservations and limitations imposed by the conditions thus summarized, it is possible, however, to make some use of the entire series of matter presented in the Annual Reports on Sea Fisheries of England and Wales. If, for instance, a certain tendency should be shown by a comparison of the several years of the earlier period inter se, and the same tendency should be shown by the different sort of analysis required by the character of the data available for the second period, the two presumably would be mutually corroborative. It must be understood definitely and finally, however, that the specific data for one period must not be compared with those for the other.

FISHING REGIONS.

The fishing vessels of England and Wales fish in the following regions, which are specifically designated in the reports for recent years: White Sea, Iceland, Faroe, Rockall, North of Scotland, North Sea, English Channel, Irish Sea, Bristol Channel, Westward of Scotland, West of Ireland, Southward of Ireland, Biscay, and Portugal and Morocco. All of these regions are resorted to by English steam trawlers, in some cases to the total or practical exclusion of other methods of fishing.

Prior to 1906 there is very little specific information furnished in respect to the fisheries on these grounds, but such data as are available indicate the increasing relative importance of the more distant regions as compared with the North Sea. The landings of fish at Grimsby, Hull, and Boston, the ports from which these fisheries were predominant, as compared with the landings at six or seven other east coast ports where the North Sea fishery was paramount, showed an increase from about 73 per cent of the total in 1891 to about 82 per cent in 1901. For 1903 and later years there are specific data for the "North Sea" and "Regions beyond the North Sea"—that is, all others—and the following table shows the proportions of all demersal fish taken by English vessels in these two, respectively:

PERCENTILE PROPORTIONS OF DEMERSAL FISHES CAUGHT IN THE NORTH SEA AND IN REGIONS BEYOND THE NORTH SEA, RESPECTIVELY, BY ENGLISH AND WELSH VESSELS.

Year.	North Sea.	Beyond North Sea.
1903	79.4	20.6
1906	54.7	45.3
1912	43.2	56.8

These complete statistics confirm the deductions from the earlier partial data, that the North Sea has rapidly lost in relative importance to the whole demersal fishery, and that it has now lost its former dominance.

A discussion of all of the 14 regions previously named is not important to the purposes of this report. The North Sea, the seat of the oldest, most important, and most dominant otter-trawl fishery, furnishes the data of most value, and that region is, therefore, considered at the greatest length, but for purposes of comparison, and as a check on the deductions made, it is desirable to analyze the information obtainable respecting certain other regions resembling it in the character of the fishery and the fishes caught. The most suitable for this purpose appear to be Iceland, the White Sea, and Faroe. The areas of the fishing grounds of the four regions, according to the best information obtainable, are as follows:

	Square miles.
North Sea	152,500
Iceland	36,600
White Sea	128,900
Faroe	4,950

These areas, certainly in the case of the North Sea and probably in other cases, are the totals of the waters to which the fishermen resort, and it is at least probable that the whole is not equally productive and that some parts may be practically or completely barren

of commercial fishes. Certainly, some parts of the North Sea produce comparatively little, some produce practically nothing but small fish, while others, e. g., Dogger Bank, are highly productive. Probably all of these regions show differences in their several parts, and the product differs with the physical characters. The North Sea south of a line from Flamborough Head to about the northwest point of Denmark is comparatively shallow and is the important plaice region. In this area small plaice abound near the shores and particularly in the southeast portion on the Dutch and German coasts, while the larger fish frequent the offshore banks. North of the line described and along the Norwegian shore the sea is deeper and the haddock becomes of relatively greater importance.

The nature of the fisheries in the North Sea, White Sea, Iceland, and Faroe, and their statistical histories, so far as it is possible to trace them from the information available, are shown in the following pages.

FISHERIES OF THE NORTH SEA.

First-class vessels.—With the exception of a wholly negligible quantity, all of the demersal fishes taken in the North Sea by English vessels are landed on the east coast. The following table makes comparison of the landings of demersal fishes as a whole, and of round fishes and flat fishes, respectively, at east coast ports, the data until 1901 being the total for certain ports and after 1903 for all ports, for reasons previously explained. As practically the entire catch is made by first-class vessels, and as these are the only vessels for which more detailed data presented later are available, they alone will be considered.

TOTAL LANDINGS OF DEMERSAL FISHES, ROUND FISHES, AND FLAT FISHES, FROM THE NORTH SEA ON THE EAST COAST OF ENGLAND IN THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Classes and periods.	Quantity (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1891–1898	570,818	508,940	− 61,875	−10
1898–1901	508,940	585,436	+ 76,496	+15
1903–1906	5,116,979	4,281,150	−835,829	−16
1906–1912	4,281,150	3,675,862	−605,288	−14
Round fishes:				
1891–1898	304,095	247,109	− 56,986	−18
1898–1901	247,109	264,470	+ 17,361	+ 7
1903–1906	3,492,414	3,158,062	−334,352	− 9
1906–1912	3,158,062	2,605,812	−552,250	−17
Flat fishes:				
1891–1898	266,723	261,831	− 44,892	− 1
1898–1901	261,831	320,966	+ 59,135	+22
1903–1906	1,492,696	970,509	−522,187	−34
1906–1912	970,509	849,003	−121,506	−12

NOTE.—The data for 1891 to 1901, inclusive, are for certain ports only, enumerated in the text.

It is apparent from the foregoing that from 1891 to 1901 the catch of demersal fishes fluctuated, but showed a slight net gain for the period, and that while the fluctuation was exhibited in the catch of both round fishes and flat fishes, the former registered a net loss and the latter a net gain for the whole period. The period from 1903 to 1912 was characterized by consistent losses in both round fishes and flat fishes, but more especially in the latter, which of course resulted in a heavy loss in demersal fishes as a whole.

The catches of cod, haddock, and plaice combined have averaged from 87 per cent of the demersal fishes taken in the North Sea to about 72 per cent; cod and haddock constitute about 90 per cent of the round fishes, and plaice from about 60 to 75 per cent of the flat fishes. The following table compares the catches of these three species in the respective years considered in this report:

TOTAL LANDINGS OF THE THREE IMPORTANT DEMERSAL FISHES FROM THE NORTH SEA ON THE EAST COAST OF ENGLAND IN THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Species and periods.	Quantity (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Cod:				
1891–1898	91,987	94,906	+ 2,919	+ 3
1898–1901	94,906	108,722	+ 13,816	+14
1903–1906	783,782	740,062	− 43,720	− 5
1906–1912	740,062	825,636	+ 85,574	+11
Haddock:				
1891–1898	185,877	125,457	− 60,420	−32
1898–1901	125,457	124,102	− 1,355	− 1
1903–1906	2,310,340	2,046,204	−264,136	−11
1906–1912	2,046,204	1,293,080	−753,124	−36
Plaice:				
1891–1898	200,475	207,933	+ 7,458	+ 3
1898–1901	207,933	270,635	+ 62,702	+30
1903–1906	956,358	570,862	−385,496	−40
1906–1912	570,862	527,088	− 43,774	− 7

NOTE.—The data from 1891 to 1901, inclusive, are for certain ports only, enumerated in the text.

From this table it appears that the total catch of cod increased during the period from 1891 to 1901, but fluctuated, although registering a small net gain from 1903 to 1912; the total yield of haddock from the North Sea decreased consistently and heavily in both periods, while the plaice gained throughout the first period and lost heavily in the second.

First-class steam trawlers.—The landings of fish by steam trawlers prior to 1903 are not separately given, but it can be safely assumed on the authority of a statement made in the report for 1901 that the vast majority of the fish listed in the preceding tables for the years

1891 to 1901, inclusive, were taken by this class of vessels. The trend of the catch of demersal fishes by steam trawlers is therefore indicated by that of first-class vessels as a whole. After 1902 the information is specifically given and is shown in the following table:

QUANTITIES OF DEMERSAL FISHES, CLASSES, AND CERTAIN KINDS FROM THE NORTH SEA LANDED ON THE EAST COAST OF ENGLAND BY FIRST-CLASS STEAM TRAWLERS IN THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Classes, species, and periods.	Catch (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1903–1906	4,776,081	3,983,020	−793,061	−16
1906–1912	3,983,020	3,361,391	−621,629	−15
Round fishes:				
1903–1906	3,382,316	3,074,932	−307,382	− 9
1906–1912	3,074,932	2,464,094	−610,838	−19
Flat fishes:				
1903–1906	1,264,122	761,393	−502,729	−39
1906–1912	761,393	634,157	−127,236	−16
Cod:				
1903–1906	729,311	705,306	− 24,005	− 3
1906–1912	705,306	786,481	+ 82,175	+11
Haddock:				
1903–1906	2,301,505	2,034,882	−266,623	−11
1906–1912	2,034,882	1,292,743	−742,139	−36
Plaice:				
1903–1906	811,637	440,920	−370,717	−45
1906–1912	440,920	386,690	− 54,230	−11

NOTE.—The quantities for 1906 are the landing in England and Wales, but almost if not quite all were landed on the east coast.

As the cod, haddock, and plaice are the important species, the foregoing data dealing with single years have been checked by comparing the catches of these species for three overlapping four-year periods between 1903 and 1912, inclusive. It will be seen that the results are essentially similar, as indicated by the trend of the total catches of these species by trawlers in the North Sea.

PERCENTILE RATIOS OF CATCHES OF COD, HADDOCK, AND HAKE BY STEAM TRAWLERS IN THE NORTH SEA, 1906 TO 1909, AND 1909 TO 1912, COMPARED WITH 1903 TO 1906.

Four-year periods.	Percentile ratios.		
	Cod.	Haddock.	Hake.
1903–1906	100	100	100
1906–1909	105	93	73
1909–1912	122	68	64

It appears that the catch of demersal fish in the North Sea by steam trawlers decreased from 1891 to 1898 and increased sufficiently from 1898 to 1901 to show a small net increase for the entire period,

and that round fishes and flat fishes each followed the same general trend. From 1903 to 1906 and again from 1906 to 1912 steam trawl-caught demersal fishes as a whole, as well as both round fishes and flat fishes, showed heavy decreases, the total percentile falling off in the flat fishes being the greatest.

Steam trawl-caught cod gained in total catch from 1891 to 1898 and from 1898 to 1901 but exhibited a falling off of about 3 per cent from 1903 to 1906. From 1906 to 1912, however, there was a material increase, and it is apparent that the total catch of the species by trawlers increased more or less continuously from 1891 to 1912. Steam trawl-caught haddock on the contrary declined in total throughout the entire time, and in the two periods, from 1891 to 1901, and from 1903 to 1912, the decreases amounted to 33 per cent and 44 per cent, respectively. In the case of the plaice there was an increase in the catch between both 1891 and 1898 and 1898 and 1901, the aggregate of the two amounting to 35 per cent of the catch of 1891. In both 1906 and 1912 the catch was much less than in 1913, and the decrease in the entire period was nearly 53 per cent. For the entire term from 1891 to 1912 there was, therefore, an increase in the total catch of cod by steam trawlers and a decrease in the catches of haddock and plaice, especially the former.

The foregoing discussion is concerned with the total catches of the several classes, categories, and kinds of fishes; but while the indicated changes were taking place there were synchronous but not necessarily parallel changes in the composition and fishing power of the fleet and variations in the intensity of the fishery conducted by it. To eliminate these variables as far as possible the catch may be reduced to the average per vessel, the average per voyage, or the average per day's absence from port. The first is objectionable in that it does not eliminate the effects of variations in the number of vessels tied up for variable and undeterminable periods, and we have, therefore, confined ourselves to the consideration of the other two.

Unfortunately these methods of analysis can not be applied at all prior to 1903, as the data are not furnished in the reports, and for 1903 and the following years the average catch per day's absence is stated for a part only of the total catch (that not landed in London where most of the fish are brought in by carriers and not by the fishermen). The catch per voyage is not given at all, although the average duration of the voyages is given for all ports excluding London.

As this information applies to the major portion of the fishing operations, it may be assumed that it is reasonably applicable to all,

and, following a suggestion in the report of 1906,[a] we have calculated from these data the hypothetical number of voyages and days' absence required to catch all of the fish taken by English trawlers in the North Sea. The following tables are based on the factors so derived.

The total number of steam trawlers in England and Wales does not appear ascertainable for 1891 and 1898, but there were about 500 in 1893 and 1,116 in 1899. In 1901 there were 1,096; in 1903, 1,135; in 1906, 1,254; and in 1912, 1,341. While this rapid increase in the fleet was occurring there was a continuous growth in the size of the vessels from an average of 41 tons in 1893 to 72 tons in 1912. There was, therefore, not only a heavy increase in the size of the fleet, but also in the fishing power and efficiency of its units. Not all of these vessels fished in the North Sea, and some of them fished both there and elsewhere. We have no data as to the number fishing there in any year, but for 1903 and later years there is available the more specific information concerning the number of landings and the number of voyages referred to in the preceding paragraphs.

TOTAL NUMBER OF DAYS' ABSENCE AND THE TOTAL NUMBER OF VOYAGES (LANDINGS) BY STEAM TRAWLERS FISHING IN THE NORTH SEA FROM PORTS ON THE EAST COAST OF ENGLAND.

Periods.	Number during—		Loss.	
	First year.	Last year.	Number.	Per cent.
Total days' absence:				
1903–1906	256,228	225,923	30,305	11.8
1906–1912	225,923	213,286	12,637	5.5
Number of voyages (landings):				
1903–1906	36,852	36,474	378	1.0
1906–1912	36,474	36,118	356	.9

The number of days' absence from port has decreased, while the number of landings has remained practically stationary. The average length of voyages, therefore, has decreased from 6.95 days in 1903 to 5.73 days in 1912, a development probably due to the increased steaming and fishing gear and improvement in the general efficiency of the vessels and their gear. That the number of landings has not increased with the increase in the number and power of English trawlers indicates that to a relatively greater extent than formerly the vessels are fishing in regions other than the North Sea, a fact known from other sources of information.

[a] Annual Report Sea Fisheries, England and Wales, 1906, pp. viii–xi.

AVERAGE CATCH OF STEAM TRAWLERS FISHING IN THE NORTH SEA FROM THE EAST COAST OF ENGLAND PER DAY OF ABSENCE DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Species and periods.	Catch (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1903–1906	18.64	17.63	−1.0	− 5
1906–1912	17.63	15.76	−1.9	−10
Cod:				
1903–1906	3.1	3.5	+0.4	+12
1906–1912	3.5	4.45	+0.9	+27
Haddock:				
1903–1906	8.3	7.8	−0.5	− 6
1906–1912	7.8	4.8	−3.0	−38
Plaice:				
1903–1906	3.1	2.1	−1.0	−30
1906–1912	3.1	2.34	+0.2	+11

AVERAGE CATCH PER VOYAGE OF STEAM TRAWLERS FISHING IN THE NORTH SEA FROM THE EAST COAST OF ENGLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Species and periods.	Catch (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1903–1906	129.6	109.2	−20.4	−15
1906–1912	109.2	90.3	−18.9	−17
Cod:				
1903–1906	21.7	21.9	+ 0.2	+ 9
1906–1912	21.9	25.8	+ 3.9	+17
Haddock:				
1903–1906	57.9	48.5	− 9.4	−16
1906–1912	48.5	27.4	−21.1	−43
Plaice:				
1903–1906	21.2	13.3	− 7.9	−32
1906–1912	13.3	13.4	+ 0.1	+ 0.7

These two tables show the same facts, namely, that on whichever basis computed, the average catch of demersal fishes by steam trawlers has decreased from 1903 to 1912, the average catch of cod has materially increased, while the yields of haddock and plaice per unit of effort have decreased, the former over 53 per cent and the latter over 37 per cent.

A frequent manifestation of the results of overfishing is the permanent relative increase in the catch of small fishes, particularly if the absolute quantity of the catch of large fishes or of the species as a whole remains stationary or diminishes.

As a fishery increases, the total quantities of the catch will also increase, while the ratios existing between the catch of the various sizes will be maintained provided that the size and composition of the fish schools remain unimpaired. When overfishing occurs, however, there is a tendency to change the composition of the schools

even though the aggregate number of individuals composing them may not be reduced. The larger fish are taken in at least the full proportion in which they exist in the schools and at the same time increased numbers of the immediately smaller fishes are taken and fewer are left to develop into large, and the numbers of the latter are gradually reduced both absolutely and relatively. We have a particularly well-known and conspicuous example of this in the lobster fisheries of New England.

The following table analyzes the catches of cod, haddock, and plaice in respect to their relative size components:

PERCENTILE RATIOS OF EACH SIZE OF COD, HADDOCK, AND PLAICE TO TOTAL OF ALL SIZES LANDED IN ENGLAND AND WALES FROM THE NORTH SEA BY FIRST-CLASS STEAM TRAWLERS IN 4-YEAR PERIODS, 1903 TO 1912, INCLUSIVE.

Species and sizes.	Percentile ratios to all sizes.[a]		
	1903–1906	1906–1909	1909–1912
Cod:			
Large	43	42	33
Medium	30	25	25
Small	26	33	42
Haddock:			
Large	29	30	39
Medium	28	15	13
Small	43	55	48
Plaice:			
Large	24	25	21
Medium	31	30	32
Small	45	45	47

[a] In 1903 the data of landings on the east coast only are available, but the landings elsewhere were negligible.

It will be seen that the cod shows a material reduction in the ratio of large fish to the total, a smaller reduction in the medium fish, and a heavy increase in the ratio of small. The plaice exhibits a slight reduction in the relative catch of large fish, and a corresponding increase in the small, the proportion of medium fish remaining about constant.

The haddock, on the contrary, shows an increase in the ratio of both large and small at the expense of the medium size. So far as the large fish are concerned, we believe the actual facts to be other than as shown, and that the statistical increase has been due to the transfer of what were formerly classed as medium fish to the category of large. We know from official statements that there are no definite standards of size, and that they vary from time to time. In the face of the relatively high price of the large haddock, the absolute great increase in that price in the last 10 years, and the absolute decrease in the catch of that size, it appears to us to be more than probable that the standards have been lowered, and that all categories are as an average smaller fish than formerly. Even if this be the case, the combined catch of large and medium haddock

were somewhat smaller in the quadrennial period 1909–1912 and much smaller in 1906–1909 than it was in 1903–1906.

First-class sailing trawlers.—The number of first-class sailing trawlers operating in the North Sea is not definitely determinable, but it is small relatively to the steam trawlers. In all England there was a heavy decrease in this class of vessels from 1891 to 1901, but since then the number has been practically uniform, and it may be assumed that the vessels in the North Sea followed the same course. Specific data of the catch of the sailing trawlers are available after 1902 and are shown in the following tables, which are presented with nothing more than the comment that the operations of these vessels, so far as the catch is concerned, are of such relatively insignificant proportions that they are not worthy of consideration excepting to show that they are insignificant.

QUANTITIES OF DEMERSAL FISHES, CLASSES, AND CERTAIN KINDS FROM THE NORTH SEA LANDED ON THE EAST COAST OF ENGLAND BY FIRST-CLASS SAILING TRAWLERS IN THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Classes, species, and periods.	Catch (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1903–1906	277,530	262,504	−15,026	− 5
1906–1912	262,504	279,055	+16,551	+ 6
Round fishes:				
1903–1906	40,004	50,531	+10,527	+26
1906–1912	50,531	55,469	+ 4,938	+ 9
Flat fishes:				
1903–1906	217,502	206,975	−10,527	− 4
1906–1912	206,975	208,072	+ 2,097	+ 1
Cod:				
1903–1906	22,953	17,122	− 5,831	−25
1906–1912	17,122	14,500	− 2,622	−15
Haddock:				
1903–1906	1,059	1,447	+ 386	+36
1906–1912	1,447	0	.....	.....
Plaice:				
1903–1906	144,667	129,956	−14,711	−10
1906–1912	129,956	140,300	+20,344	+15

AVERAGE CATCH PER DAY'S ABSENCE OF SAILING TRAWLERS IN THE NORTH SEA FROM THE EAST COAST OF ENGLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Species and periods.	Quantity (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1903–1906	3.11	2.45	−0.66	−21
1906–1912	2.45	3.08	.63	+25
Cod: 1906–1912	.16	.16	.....	.....
Haddock: 1906–1912	.01	.00	.....	.....
Plaice: 1906–1912	1.22	1.55	+ .33	+27

Steam liners.—Steam liners, still more than sailing trawlers, bear but an insignificant part in the North Sea fisheries of England, as may be seen by the following tables:

QUANTITIES OF DEMERSAL FISHES, CLASSES, AND CERTAIN KINDS FROM THE NORTH SEA LANDED ON THE EAST COAST OF ENGLAND BY FIRST-CLASS STEAM LINERS IN THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Classes, species, and periods.	Catch (hundredweight) during—		Gain or loss.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1903–1906	33,338	[a] 9,740	−23,648	− 70
1906–1912	[a] 9,740	20,678	+10,938	+112
Round fishes:				
1903–1906	21,898	7,973	−13,925	− 63
1906–1912	7,973	17,394	+ 9,421	+118
Flat fishes:				
1903–1906	10,197	1,688	− 8,509	− 83
1906–1912	1,688	3,265	+ 1,577	+ 93
Cod:				
1903–1906	12,451	5,555	− 6,896	− 55
1906–1912	5,555	15,031	+ 9,476	+170
Haddock:				
1903–1906	2,782	.....	.....	.....
1906–1912	.....	46	.....	.....
Plaice:				
1903–1906	54	.....	.....	.....
1906–1912	.....	.....	.....	.....

[a] Landed in all England and Wales, but probably all on east coast.

AVERAGE CATCH PER DAY'S ABSENCE OF STEAM LINERS FISHING IN THE NORTH SEA FROM THE EAST COAST OF ENGLAND IN 1906 AND 1912, RESPECTIVELY.

Species.	Catch (hundredweight) during—		Gain.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	14.78	18.28	3.50	23
Cod	8.43	11.32	2.89	34
Haddock	.....	.04	.....	.....
Plaice	.....	.....	.....	.....

SUMMARY OF CONDITIONS IN THE NORTH SEA.

Summarizing the conditions of the fisheries of the North Sea, as shown by the examination of the English official reports, we find that since 1891 there has been a material decrease in the quantities of fishes caught, and that both round fishes and flat fishes have participated in this decrease. During this time there has been considerable change in the strength and composition of the fishing fleet, the most important of which was the substitution of the otter trawl for the beam trawl, which became practically complete as early as 1898. Since that time, at least, this apparatus has been the predominant means by which the fishery was conducted, and it catches about 90 per cent of the fish taken by all means by English vessels, and the

English trawlers take about 45 per cent of the demersal fish, and rather more than that portion of cod, haddock, and plaice taken by all nations in the North Sea.

Exact data respecting the activities and catch of this fleet, which are available since 1902 only, show that the average catch of demersal fishes, per voyage and per day's absence from port, has materially decreased between 1903 and 1912, and this decrease has occurred in both round fishes and flat fishes. There is, therefore, presumptive evidence of the depletion of the fisheries as a whole.

Cod, haddock, and plaice combined constitute about 80 per cent of the demersal fishes caught by English vessels in the North Sea, and they represent an almost equal proportion of the catch by all countries in those waters. Of these we find that the cod shows an increase in the total catch and in the averages per voyage and per day's absence, the only sign of depletion appearing in the decrease in the proportional catch of large fishes and the increase in the proportion of small ones.

The haddock shows indications of depletion in the heavy and consistent decrease in the total catch, and in the average catches per voyage and per day's absence. Statistically it shows but slight indications of overfishing in the ratios of the several sizes, but we believe this indication would be more pronounced if the standards of sizes had been maintained on equality with those of earlier years. The plaice, by every method of examination which the data will permit us to apply, shows unmistakable signs of depletion.

We believe, therefore, that there is overfishing in respect to both haddock and plaice, and that in consideration of its overwhelming predominance the otter trawl is responsible. The cod, being a rapacious, more nomadic fish, and less distinctly a bottom dweller, is not affected.

ICELAND.

The importance of the English steam-trawl fisheries in Iceland was second to that of the North Sea only in both 1906 and 1912, and the steam-line fishery in the region held first place in both years among the 14 regions enumerated in the reports. Practically no other method of fishing is pursued there by English vessels, and the trawlers took about 93 per cent of the total catch in 1906 and about 90 per cent in 1912.

In 1906 there were 1,579 and in 1912 there were 1,430 voyages by trawlers, a decrease of about 9 per cent, and the total number of days' absences decreased 11 per cent, from 35,039 days in 1906 to 30,919 days in 1912. The average duration of the voyages was nearly equal in the two years, being 22.2 days in 1906 and 21.6 days in 1912. The total catch of the trawlers and the average catch per trip are shown in the following tables:

TOTAL CATCH OF DEMERSAL FISHES, CLASSES, AND IMPORTANT KINDS BY ENGLISH STEAM TRAWLERS FISHING IN ICELAND WATERS IN 1906 AND 1912.

Classes and species.	Quantity (hundredweight).		Gain or loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	1,549,502	1,439,774	− 108,728	− 7
Round fishes	1,266,248	1,233,396	− 32,852	− 2
Flat fishes	237,431	173,323	− 64,108	− 27
Cod	729,322	800,992	+ 71,670	+ 9
Haddock	414,241	310,136	− 104,105	− 25
Plaice	186,382	121,264	− 65,118	− 34

AVERAGE CATCH PER LANDING BY ENGLISH STEAM TRAWLERS FISHING IN ICELAND WATERS IN 1906 AND 1912.

Species.	Quantity (hundredweight).		Gain or loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	1,051	1,120	+ 69	+ 6
Cod	461	560	+ 99	+ 21
Haddock	261	216	− 45	− 17
Plaice	118	84	− 34	− 28

The table of total quantities shows that there was a decrease in all fishes excepting the cod, but as is seen from a comparison of the table of average catches per voyage this was in part due to a decrease in fishing activity. Nevertheless, while there appears to have been an increase in the cod, as measured by the catch per unit of effort, there were equally considerable decreases in the haddock and plaice as measured by the same standard. In 1913 there was a further development of these tendencies, and while there was a heavy increase in the total catch of cod, due to increased fishing activity, there were material decreases in the total catches of haddock and plaice, and very heavy decreases in the average quantities per voyage, especially in plaice, of which but half as many were taken as in 1906.

PERCENTILE PROPORTIONS OF TRADE SIZES TO TOTAL OF ALL SIZES OF COD, HADDOCK, AND PLAICE FROM ICELAND, LANDED BY STEAM TRAWLERS IN QUADRENNIAL PERIODS BETWEEN 1906 AND 1912.

Species and sizes.	1906–1909	1909–1912
Cod:		
Large	67.3	57.3
Medium	19.4	21.9
Small	12.7	20.7
Haddock:		
Large	69.3	60.3
Medium	27.6	37.7
Small	3.0	1.9
Plaice:		
Large	53.9	36.6
Medium	43.8	57.7
Small	2.2	5.6

As shown in the foregoing table, the increase in the cod catch has been due to some extent to an increase in the relative quantities of the smaller sizes landed, and the decrease in the quantities of haddock and plaice, especially the latter, has occurred notwithstanding the marketing of an increased proportion of the small and medium sizes.

The statistical facts of this fishery, so far as they may be given weight on account of the brief period covered, point rather strongly to the possible depletion of the plaice fishery and to a less extent of the fishery for haddock. The cod, as appears to be the case everywhere, is unaffected.

In 1906 there were 346 voyages by English steam liners, aggregating 7,526 days of absence per port, and of an average duration of 21.7 days. In 1912 there were 521 voyages, entailing an aggregate absence of 10,268 days, and the average voyage occupied 19.6 days. The total catch of these steam liners and the average catch per voyage are shown in the following tables:

TOTAL CATCH OF DEMERSAL FISHES, CLASSES, AND IMPORTANT KINDS BY ENGLISH STEAM LINERS FISHING IN ICELAND WATERS IN 1906 AND 1912.

Classes and species.	Quantity (hundredweight).		Gain or loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	111,248	162,241	+50,993	+ 45
Round fishes	20,826	82,859	+62,033	+297
Flat fishes	83,847	74,300	− 9,547	− 11
Cod	13,954	58,388	+44,434	+318
Haddock	175	659	+ 484	+276

AVERAGE CATCH PER LANDING BY ENGLISH STEAM LINERS FISHING IN ICELAND WATERS IN 1906 AND 1912.

Species.	Quantity (hundredweight).		Gain or loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	321	311	−10	− 3
Cod	40	112	+72	+180
Haddock	.5	1	+ .5	+100

It will be seen that no plaice were taken in these fisheries, and the catch of haddock, the other species of particular significance in this inquiry, was negligible. The decrease in flat fishes is due to the halibut, the principal species of that class taken by the liners. There

was a heavy increase in cod. Very few small fishes of any kind are taken on lines, as will appear from the following table:

PROPORTIONS OF TRADE SIZES TO TOTAL CATCH OF ALL SIZES OF COD AND HADDOCK FROM ICELAND LANDED BY ENGLISH STEAM LINERS IN QUADRENNIAL PERIODS BETWEEN 1906 AND 1912.

Species and sizes.	1906-1909	1909-1912
Cod:		
Large	99.6	97.7
Medium	.31	2.1
Haddock:		
Large	92.1	100.0
Medium	7.8	.....

WHITE SEA.

The fishery by English vessels in this region was conducted solely by steam trawlers, and, considering steam vessels only, it ranked eighth in catch among the 14 enumerated regions in 1906 and sixth in 1912. In 1906 there were 41 voyages to the White Sea, aggregating 1,129 days, and with an average length of 27.5 days. In 1912 there were 212 voyages, an increase of 419 per cent, aggregating 5,490 days of absence from port, an increase of 386 per cent, and having an average length of 25.9 days, a slight decrease. There are no specific data available for years prior to 1906. The total catch of fishes, by classes and important species, is shown in the following table:

TOTAL CATCH OF DEMERSAL FISHES, CLASSES, AND IMPORTANT KINDS BY ENGLISH STEAM-TRAWL VESSELS FISHING IN THE WHITE SEA IN 1906 AND 1912.

Classes and species.	Quantity (hundredweight).		Gain.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	45,330	210,636	165,306	364
Round fishes	6,083	95,813	89,730	1,310
Flat fishes	39,210	113,945	74,735	190
Cod	1,089	52,137	51,046	4,686
Haddock	4,480	40,297	35,917	799
Plaice	39,176	110,848	71,672	182

This fishery was originally undertaken primarily for plaice, which constituted over 86 per cent of the total catch in 1906, but while the quantity of this species had increased about 183 per cent in 1912 the catch of cod and haddock had increased more rapidly and plaice comprised less than 53 per cent of the combined catch of the three species in 1912. To eliminate the statistical effects of the increase in

fishing activity and reduce the catches to the basis of units of effort expended in making them, the following table is presented:

AVERAGE CATCHES PER LANDING BY ENGLISH STEAM-TRAWL VESSELS FISHING IN THE WHITE SEA IN 1906 AND 1912.

Species.	Quantity (hundredweight).		Gain or loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	1,105	993	−112	− 10
Cod	27	246	+219	+811
Haddock	109	190	+ 81	+ 74
Plaice	956	523	−433	− 45

It will be seen from this that the average catch of demersal fishes per voyage has decreased slightly, and of plaice, the principal species caught, heavily between 1906 and 1912. The average catches of cod and haddock have each increased, the former enormously. As the plaice is the highest-priced and most desirable fish of the three, the inference is that there was a deficiency of that species, which was made good in some measure by increased attention to the cod and haddock. This tendency appears to have been reasonably continuous throughout the period discussed. In 1913 there were but 108 voyages to the White Sea, and the average catch of the cod and plaice per voyage was about the same as in the preceding year, but there was a further increase of about 50 per cent in the average catch of haddock.

To determine whether there is any other indication of a depletion of the supply of these fishes, the following analysis has been made of the catch in respect to its composition by sizes during the two overlapping four-year periods for which information is available:

PROPORTION OF THE DIFFERENT TRADE SIZES OF COD, HADDOCK, AND PLAICE TO THE WHOLE OF THE THREE COMBINED, IN QUADRENNIAL PERIODS BETWEEN 1906 AND 1912.

Species and sizes.	1906–1909	1909–1912
Cod:	*Per cent.*	*Per cent.*
Large	11.8	9.0
Medium	22.9	55.1
Small	65.1	35.8
Haddock:		
Large	89.3	35.0
Medium	10.5	64.8
Small	.1	.1
Plaice:		
Large	28.5	30.6
Medium	71.3	69.2
Small	.....	.....

This throws but little light on the subject other than to show that the increases in the catches of cod and haddock were mainly in

the medium sizes, and to warrant the inference that probably only the larger haddock were saved in the earlier period when the species was less energetically sought. The large plaice have slightly more than maintained their proportional importance.

Considering the facts developed and the brevity of the period which it is possible to discuss, we can draw no conclusions excepting the dubious one that the supply of plaice in the White Sea may not be sufficient for the maintenance of the fishery for that species on the scale which it has attained.

FAROE.

This region, which is the smallest of the four considered in this discussion of the English fisheries, lies about midway between the North Sea and Iceland. Its product, which is about 7 per cent of all demersal fishes landed in England, is greater than that of the White Sea but less than that of Iceland.

About 85 to 90 per cent of the fishes in this region are taken by steam trawlers, which made 1,085 trips in 1906 and 1,303 in 1912. The total number of days' absence was 17,215 in 1906 and 18,445 in 1912, the average duration of the voyages in the two years being 15.8 and 14 days respectively. The total catch and the average per voyage are shown in the following tables:

TOTAL CATCH OF DEMERSAL FISHES, CLASSES, AND IMPORTANT KINDS BY ENGLISH STEAM TRAWLERS FISHING ON FAROE GROUNDS, 1906 AND 1912.

Classes and species.	Quantity (hundredweight).		Gain or loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	536,947	584,484	+47,537	+ 8
Round fishes	470,675	539,775	+69,100	+14
Flat fishes	30,231	20,155	−10,076	−33
Cod	245,364	341,704	+96,340	+39
Haddock	190,740	147,525	−43,215	−22
Plaice	4,346	989	− 3,357	−77

AVERAGE CATCH PER LANDING BY ENGLISH STEAM TRAWLERS FISHING ON FAROE GROUNDS, 1906 AND 1912.

Classes and species.	Quantity (hundredweight).		Gain or loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	495	449	−46	− 9
Round fishes	434	414	−20	− 5
Flat fishes	28	15	−13	−44
Cod	226	262	+36	+15
Haddock	176	113	−63	−35
Plaice	4	.8	− 3.2	−80

The total catch of demersal fishes showed a slight improvement, but this was due to an increase in the intensity of the fishery. The quantity of plaice taken was insignificant, the principal flat fishes of the region being halibut and skates, the combined catch of which exhibited a large decrease both in the total and the average per voyage.

Cod and haddock are the principal species taken, and of these the cod, the more important, was caught in greater quantities, while the take of haddock diminished. An examination of the following table shows that the improvement in the yield of cod was due solely to an increase in the quantity of small and medium fish marketed, the large fish undergoing an actual quantitative decrease. The same trend is shown in the catch of haddock, in which there was an actual increase in the quantities of medium and small fish in the face of a falling off in the total catch of the species.

PROPORTION OF THE TRADE CATEGORIES TO TOTAL CATCHES OF COD AND HADDOCK TAKEN ON FAROE GROUNDS BY ENGLISH STEAM TRAWLERS IN QUADRENNIAL PERIODS FROM 1906 TO 1912.

Species and sizes.	1906–1909	1909–1912
Cod:	*Per cent.*	*Per cent.*
Large	39.2	21.8
Medium	36.1	31.2
Small	24.5	46.8
Haddock:		
Large	72.2	68.2
Medium	23.4	20.6
Small	4.2	11.1

In view of the relatively small importance of the line fishery, it is not considered necessary to discuss it more than in the presentation of the following table:

TOTAL CATCH OF DEMERSAL FISHES, CLASSES, AND IMPORTANT KINDS BY ENGLISH STEAM LINERS FISHING ON FAROE GROUNDS IN 1906 AND 1912.

Classes and species.	Quantity (hundredweight).		Loss.	
	1906	1912	Hundredweight.	Per cent.
Demersal fishes	81,662	41,461	40,201	49
Round fishes	48,963	27,416	21,547	44
Flat fishes	27,661	12,788	14,873	53
Cod	29,867	14,827	15,040	50
Haddock	462	114	348	75
Plaice	4	.....	.....	.....

The Faroe fishery, as a whole, furnishes no data of value respecting the plaice, but making due allowance for the shortness of the period considered, the data available establish some presumption of a decrease in the haddock and a suspicion that there may be overfishing of the cod.

DEMERSAL FISHERIES OF SCOTLAND.

FISHING REGIONS.

The Scottish reports furnish but little specific data respecting the fishing regions, such distinctions as are made indicating merely the part of Scotland in which the fish are landed, the east coast, Orkney, and Shetland, and the west coast, respectively. The latter two are of practically no importance to the purposes of this report and are not discussed.

The major portion of the demersal fish caught in the Scottish fisheries are landed on the east coast; and as that is the region in which trawl fishing is of greatest importance, and as practically all fish taken in the North Sea by Scottish vessels are landed there, it is the only region which we have deemed it necessary to consider.

FISHERIES OF THE EAST COAST.

The statistics and the general information available for Scotland are not very satisfactory for the consideration of the effects of otter trawling on the fisheries, inasmuch as they lack, even to a greater extent than the earlier reports for England, that particularity of data which is necessary for a proper consideration of the subject. However, it is possible to trace some trend, and as this accords in general with that indicated in the English fisheries, it may be regarded, with some caution, as confirmatory of the conclusions formed respecting the latter.

In the following discussion the same historical periods and subperiods are considered, partly for the sake of uniformity with the discussion of the English data and partly because the forms of the statistics underwent some change in the years of demarcation, or because some change in the fishery became definitive in those years. For instance, 1898 is the first year concerning which it is known that all steam trawlers were using the otter trawl, which had gradually replaced the beam trawl; in 1904 there was a change in the classification of the fishes; and in 1906 there was a material change in the particularity of the statistics in respect to certain important fisheries. The effects of these changes have been eliminated as far as possible in the following pages, but their existence dictated the form of the more comprehensive digest found in the appendix and colored the form of final presentation of the data adduced.

THE CATCH AS A WHOLE.

The east coast was by far the most important producer of demersal fishes in Scotland, the catch of that region in 1891 being over 70 per cent of the total product of the country and in 1912 over 76 per cent.

The statistical history of the yield of the region is shown in the following table:

CATCHES OF DEMERSAL FISHES AND THE SEVERAL CLASSES ON THE EAST COAST OF SCOTLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Classes and periods.	Quantity (hundredweight) during—		Increase or decrease	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1891–1898	1,339,051	1,465,426	+ 126,375	+ 9
1898–1901	1,465,426	1,724,525	+ 259,099	+ 17
1901–1903	1,724,525	1,955,718	+ 231,193	+ 13
1903–1906	1,955,718	2,299,311	+ 343,593	+ 17
1906–1912	2,299,311	2,544,897	+ 245,586	+ 10
1891–1912	1,339,051	2,544,897	+1,205,846	+ 90
Round fishes: [a]				
1891–1898	1,127,452	1,267,938	+ 140,486	+ 12
1898–1901	1,267,938	1,413,385	+ 145,447	+ 11
1901–1903	1,413,385	1,668,275	+ 254,890	+ 18
1903–1906	1,668,275	1,979,205	+ 310,930	+ 18
1906–1912	1,979,205	2,179,555	+ 200,350	+ 10
1891–1912	1,127,452	2,179,555	+1,052,103	+ 93
Flat fishes: [a]				
1891–1898	94,745	101,460	+ 6,715	+ 7
1898–1901	101,460	170,013	+ 68,553	+ 67
1901–1903	170,013	164,295	− 5,718	− 3
1903–1906	164,295	139,282	− 25,013	− 15
1906–1912	139,282	135,063	− 4,219	− 3
1891–1912	94,745	135,063	+ 40,318	+ 42
Unclassified fishes: [b]				
1891–1898	84,347	47,373	− 36,974	− 43
1898–1901	47,373	81,182	+ 33,809	+ 71
1901–1903	81,182	61,265	− 19,917	− 24
1903–1906	61,265	105,256	+ 43,991	+ 71
1906–1912	105,256	119,810	+ 14,554	+ 13
1891–1912	84,347	119,810	+ 35,463	+ 42
Skates:				
1891–1898	32,506	48,655	+ 16,149	+ 49
1898–1901	48,655	59,945	+ 11,290	+ 23
1901–1903	59,945	61,883	+ 1,888	+ 3
1903–1906	61,883	75,568	+ 13,735	+ 22
1906–1912	75,568	110,469	+ 34,901	+ 46
1891–1912	32,506	110,469	+ 77,963	+239

[a] Excluding fishes classified after 1903. [b] Including fishes classified after 1903.

From the foregoing table it is seen that there has been a constant and fairly uniform increase in the catch of demersal fishes, amounting in the aggregate to about 90 per cent from 1891 to 1912, and that both relatively and quantitatively this has been in major part produced by the constant increase in the catch of round fishes, which in the same period increased 93 per cent in quantity.

Flat fishes registered an increase of 42 per cent for the period, due mainly to a heavy increase from 1898 to 1901, after which there was a decrease to and including 1912. Unclassified fishes, including those classified after 1903, fluctuated until 1903, but increased afterwards until the total at the end of the period was 42 per cent greater than in 1891. The catch of skates increased heavily and continuously throughout the period.

Cod, haddock, flounder, plaice and brill, and halibut are the most important species of demersal fishes landed on the east coast of Scotland, and these kinds combined constituted 55.8 per cent of the land-

ings of demersal fishes of all Scotland in 1891, and about 53.3 per cent in 1912. Cod and haddock landed on the east coast in 1891 constituted nearly 61 per cent of Scottish round fishes and in 1912 nearly 57 per cent. In 1891 the flat fishes enumerated comprised about 43 per cent, and in 1912, 25 per cent of the country's landing of flat fishes. Furthermore, the catch of each of these species on the east largely exceeds the catch in all other regions. For these reasons, it is necessary to consider these fishes only in discussing the fluctuations of the fishery.

CATCH PER ANNUM AT THE BEGINNING AND ENDING OF CERTAIN PERIODS OF EACH OF THE MORE IMPORTANT SPECIES OF DEMERSAL FISHES LANDED ON THE EAST COAST OF SCOTLAND.

Species and periods.	Quantity (hundredweight) during—		Increase or decrease.	
	First year.	Last year.	Hundredweight.	Per cent.
Cod:				
1891-1898	310,020	429,431	+119,411	+ 38
1898-1901	429,431	353,506	− 75,925	− 17
1901-1903	353,506	454,527	+101,021	+ 28
1903-1912	454,527	833,636	+379,108	+ 83
1891-1912	310,020	833,636	+523,616	+168
Haddock:				
1891-1898	672,156	701,514	+ 29,358	+ 4.3
1898-1901	701,514	795,883	+ 94,369	+ 13
1901-1903	795,883	962,122	+166,239	+ 14
1903-1906	962,122	1,027,988	+ 65,866	+ 68
1906-1912	1,027,988	853,710	−174,278	− 16
1891-1912	672,156	853,710	+181,554	+ 27
Halibut:				
1891-1898	7,850	19,000	+ 11,150	+142
1898-1901	19,000	30,377	+ 11,337	+ 59
1901-1903	30,377	27,350	− 3,027	− 9.9
1903-1906	27,350	34,168	+ 6,818	+ 24
1906-1912	34,168	43,758	+ 9,590	+ 28
1891-1912	7,850	43,758	+ 35,908	+ 45
Flounders, plaice, and brill:				
1891-1898	64,929	59,276	− 5,653	− 8.7
1898-1901	59,276	112,070	+ 52,794	+ 89
1901-1903	112,070	101,710	− 10,360	− 9.2
1903-1906	101,710	66,861	− 34,849	− 34
1906-1912	66,861	47,702	− 19,159	− 28
1891-1912	64,929	47,702	− 17,227	− 26
Skate:				
1891-1898	32,506	48,655	+ 16,149	+ 49
1898-1901	48,655	59,945	+ 11,290	+ 25
1901-1903	59,945	61,883	+ 1,938	+ 3.2
1903-1906	61,883	75,568	+ 13,685	+ 22
1906-1912	75,568	110,469	+ 34,901	+ 46
1891-1912	32,506	110,469	+ 77,963	+239

From the foregoing it is apparent that both the cod and haddock, but especially the former, landed on the east coast of Scotland, exhibited material increases in total quantity between 1891 and 1912, and this increase occurred in all of the periods considered excepting from 1898 to 1901 in the case of the cod, and 1906 to 1912 in the case of the haddock. Halibut increased for the whole period and showed a recession only between 1901 and 1903, while flounder, plaice, and brill decreased on the whole and showed improvement between 1901

and 1903 only. Skates increased constantly and consistently throughout the entire period considered. The increase in round fishes previously noted is therefore due principally to cod, but in a considerable part to haddock also. The increase in flat fishes is due mainly to the improved catch of halibut.

STEAM TRAWLERS.

In 1891 over 98 per cent and in 1912 over 95 per cent of the steam trawlers of Scotland hailed from the east coast. The composition of the fleet prior to 1898 is not known, but it probably contained some beam trawlers, but in 1898, and thenceforth to the present time, all of the vessels were equipped with the more efficient otter trawl. The statistical history of this fleet is shown in the following table:

NUMBER OF SCOTCH AND FOREIGN STEAM OTTER TRAWLERS ON THE EAST COAST OF SCOTLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Period.	Number during—		Increase or decrease.	
	First year.	Last year.	Number.	Per cent.
1891–1898	60	144	+ 84	+123
1898–1901	144	254	+110	+ 77
1901–1903	254	273	+ 19	+ 7
1903–1906	273	261	− 12	− 4
1906–1912	261	306	+ 45	+ 17
1891–1912	60	306	+246	+410

TOTAL CATCH BY STEAM TRAWLERS ON THE EAST COAST OF SCOTLAND IN THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Classes and periods.	Quantity (hundredweight) during—		Increase or decrease.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1891–1898	332,950	778,731	+ 445,781	+133
1898–1901	778,731	1,310,907	+ 532,176	+ 68
1901–1903	1,310,907	1,543,679	+ 232,772	+ 17
1903–1906	1,543,679	1,837,146	+ 293,467	+ 19
1906–1912	1,837,146	1,934,337	+ 97,191	+ 5
1891–1912	332,950	1,934,337	+1,601,387	+480
Round fishes:				
1891–1898	212,020	660,609	+ 448,589	+211
1898–1901	660,609	1,079,526	+ 418,917	+ 63
1901–1903	1,079,526	1,322,463	+ 242,937	+ 22
1903–1906	1,322,463	1,585,889	+ 263,426	+ 19
1906–1912	1,585,889	1,683,215	+ 97,326	+ 6
1891–1912	212,020	1,683,215	+1,471,195	+693
Flat fishes:				
1891–1898	80,492	69,183	− 11,309	− 14
1898–1901	69,183	112,998	+ 43,815	+ 63
1901–1903	112,998	129,175	+ 16,177	+ 14
1903–1906	129,175	104,417	− 24,758	− 19
1906–1912	104,417	84,413	− 20,004	− 19
1891–1912	80,492	84,413	+ 3,921	+ 4

The catch of demersal fish by steam trawlers increased constantly during the period from 1891 to 1912, and at the end was 480 per cent greater than at the beginning. This was made up mainly of round fishes, taking into consideration those species only which were so classified in all years. If to these were added the species which were classified after 1903, the increase would be practically entirely among the round fishes.

The catch of flat fishes fluctuated, but there was a practical parity between 1891 and 1912, notwithstanding a heavy increase in the fleet shown in another place in this report. The history of the catch of the principal species of round fishes and flat fishes is shown in the following table:

TOTAL CATCH OF IMPORTANT SPECIES OF FISHES BY STEAM OTTER TRAWLERS ON THE EAST COAST OF SCOTLAND IN THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Species and periods.	Quantity (hundredweight) during—		Increase or decrease.	
	First year.	Last year.	Hundredweight.	Per cent.
Cod:				
1891–1898	33,589	165,593	+132,004	+ 392
1898–1901	165,593	203,099	+ 37,506	+ 28
1901–1903	203,099	311,928	+108,819	+ 53
1903–1906	311,928	462,476	+150,448	+ 48
1906–1912	462,476	571,694	+109,222	+ 23
1891–1912	33,589	571,694	+538,105	+ 1,062
Haddock:				
1891–1898	157,059	461,208	+304,149	+ 193
1898–1901	461,208	706,403	+245,195	+ 53
1901–1903	706,403	826,122	+119,719	+ 16
1903–1906	826,122	868,137	+ 42,015	+ 5
1906–1912	868,137	469,099	−399,038	− 45
1891–1912	157,059	469,099	+312,040	+ 198
Halibut:				
1891–1898	34	1,520	+ 1,486	+ 4,370
1898–1901	1,520	6,665	+ 5,145	+ 338
1901–1903	6,665	7,399	+ 734	+ 11
1903–1906	7,399	12,679	+ 5,280	+ 71
1906–1912	12,679	8,235	− 4,444	− 34
1891–1912	34	8,235	+ 8,201	+24,120
Flounders, plaice, and brill:				
1891–1898	51,084	44,595	− 6,489	− 12
1898–1901	44,595	93,868	+ 49,273	+ 110
1901–1903	93,868	86,703	− 7,165	− 12
1903–1906	86,703	53,711	− 32,992	− 38
1906–1912	53,711	35,000	− 18,711	− 34
1891–1912	51,084	35,000	− 16,084	− 31
Skate:				
1891–1898	7,871	11,092	+ 3,221	+ 40
1898–1901	11,092	25,639	+ 14,547	+ 131
1901–1903	25,639	33,342	+ 7,903	+ 30
1903–1906	33,342	40,707	+ 7,365	+ 22
1906–1912	40,707	49,831	+ 9,124	+ 22
1891–1912	7,871	49,831	+ 41,959	+ 533

Cod and haddock, particularly the former, provided the major part of the recorded increase in round fishes, but their relative importance to the total catch of round fishes changed materially. In 1891 cod constituted about 16 per cent of trawled round fishes, and in 1912 over 33 per cent, while the proportion of haddock fell from 75 per cent to about 28 per cent. It appears from this

that, considering the increase in the fishing power of the trawl fleet, there was either a depletion of the haddock or the vessels resorted to other grounds, which would imply, although not positively indicate, the same thing. A decrease in haddock would require increased attention to other species, e. g., the cod, to maintain the productiveness of the fishery. This is further elucidated in considering the average catch of the trawlers.

In the case of flat fishes, halibut, which were of no importance in the catch in 1891, increased to almost 10 per cent of the whole class in 1912, while the category of flounder, plaice, and brill, which comprised over 60 per cent in 1891, was reduced to about 42 per cent in 1912. This leads to the same assumptions as in the case of the cod and haddock. In other words, the most important fishes in 1891 showed signs of depletion in 1912.

The average catch per vessel probably furnishes the best available criterion for comparison of the condition of the fishery in the several periods, and these data are tabulated below. The average per voyage and per days' absence can not be computed for lack of data.

AVERAGE CATCH PER ANNUM PER STEAM OTTER TRAWLER ON THE EAST COAST OF SCOTLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Classes and periods.	Quantity (hundredweight) during—		Increase or decrease.	
	First year.	Last year.	Hundredweight.	Per cent.
Demersal fishes:				
1891–1898	5,549	5,407	− 142	− 2
1898–1901	5,407	5,161	− 246	− 4
1901–1903	5,161	5,654	+ 493	+ 9
1903–1906	5,654	7,038	+1,384	+24
1906–1912	7,038	6,321	− 717	−10
1891–1912	5,549	6,321	+ 772	+13
Round fishes:				
1891–1898	3,533	4,587	+1,054	+29
1898–1901	4,587	4,250	− 337	− 7
1901–1903	4,250	4,844	+ 594	+13
1903–1906	4,844	6,076	+1,234	+25
1906–1912	6,076	5,500	− 576	− 9
1891–1912	3,533	5,500	+1,967	+55
Flat fishes:				
1891–1898	1,340	480	− 860	−64
1898–1901	480	444	− 36	− 7
1901–1903	444	473	+ 29	+ 6
1903–1906	473	400	− 73	−15
1906–1912	400	275	− 125	−31
1891–1912	1,340	275	−1,065	−79

The average catch per steam trawler in respect to demersal fishes fluctuated irregularly between 1891 and 1912 but exhibited a net increase of about 13 per cent. The total yield of the fishery, therefore, a little more than kept pace with the increase in the number of vessels but did not increase in proportion to the probable fishing

power as measured by the increase in average tonnage and general efficiency.

Such improvement in the average yield as has been noted was due to round fishes alone, the average yield of that class in 1912 having increased about 55 per cent. Flat fishes in 1912 exhibited a loss of 79 per cent as compared with 1891, and the decrease was continuous between those years with the exception of a small increase between 1901 and 1903.

AVERAGE CATCH OF CERTAIN SPECIES PER ANNUM PER STEAM OTTER TRAWLER ON THE EAST COAST OF SCOTLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Species and periods.	Quantity (hundredweight) during—		Increase or decrease.	
	First year.	Last year.	Hundredweight.	Per cent.
Cod:				
1891-1898	559	1,149	+ 590	+ 105
1898-1901	1,149	799	− 350	− 30
1901-1903	799	1,142	+ 343	+ 43
1903-1906	1,142	1,771	+ 629	+ 55
1906-1912	1,171	1,864	+ 93	+ 5
1891-1912	559	1,864	+1,305	+ 233
Haddock:				
1891-1898	2,617	3,202	+ 585	+ 22
1898-1901	3,202	2,781	− 421	− 13
1901-1903	2,781	3,027	+ 246	+ 9
1903-1906	3,027	3,330	+ 303	+ 10
1906-1912	3,330	1,533	−1,797	− 54
1891-1912	2,617	1,533	−1,084	− 41
Halibut:				
1891-1898	.56	10	+ 9.5	+1,696
1898-1901	10	26	+ 16	+ 160
1901-1903	26	27	+ 1	+ 4
1903-1906	27	48	+ 21	+ 77
1906-1912	48	26	− 22	− 45
1891-1912	.56	26	+ 25	+4,542
Flounders, plaice, and brill:				
1891-1898	851	309	− 542	− 64
1898-1901	309	369	+ 60	+ 20
1901-1903	369	317	− 52	− 14
1903-1906	317	205	− 112	− 35
1906-1912	205	114	− 91	− 44
1891-1912	851	114	− 737	− 86
Skate:				
1891-1898	131	77	− 54	− 41
1898-1901	77	100	+ 23	+ 30
1901-1903	100	122	+ 22	+ 22
1903-1906	122	156	+ 34	+ 28
1906-1912	156	162	+ 6	+ 4
1891-1912	131	162	+ 31	+ 23

An analysis of the foregoing table shows that the cod was the chief contributor to the increase in round fishes, increasing 233 per cent. This species supplanted the haddock in 1912 as the most important round fish, although the latter maintained its quantitative supremacy in decreasing ratio to 1906. The average catch of haddock underwent various vicissitudes of increase and decrease, but showed a net decrease of 41 per cent for the period as a whole. Eliminating the subperiod 1906 to 1912, there was a net increase of

27 per cent, but even so its importance as compared with the cod showed a marked recession.

The category of flounder, plaice, and brill was the most important element in the decrease of flat fishes, falling off almost continuously until in 1912 the average quantity taken by trawler was but 14 per cent of that of 1891. So far as trawlers are concerned, this category may be regarded as practically composed of plaice, as the quantity of the other two species comprised hardly more than 10 per cent in 1906 and probably less than that in earlier years.

It is evident, then, that, certainly with the plaice and probably with the haddock, the two essentially trawl-caught fish, the catch per trawler shows significant reduction, notwithstanding the presumably increased efficiency of the vessels as measured by their increased size. As has been previously suggested in the discussion of the total catch by trawlers, this appears to mean that there is a depletion of the supply of these fishes on the grounds frequented by these vessels, or that the vessels are fishing to an increasing extent on grounds little resorted to in the earlier years of the period discussed. The possible change in grounds in favor of the cod and to the detriment of the haddock and plaice catch can hardly, if it occurred, have any other reason than the depletion of the supply of the latter two species on the grounds previously resorted to, for the plaice has always been a more valuable species than the cod, and the haddock, while of approximately equal value to the cod in 1908 and previously, is now more valuable.

The halibut is more valuable than any of the other fishes mentioned, but the quantitative increase is not sufficient to offer an explanation of a change of fishing grounds, although the fact of the increase probably indicates that such change has occurred. There are no specific data to show where the fleet fished in the several years.

The only other basis on which the foregoing comparisons could be made while eliminating the statistical effects of changes in the intensity of fishing activity would be through the consideration of the catch per landing. The data necessary are not available for the east coast as a whole, but they are recorded for the trawlers fishing out of the ports of Montrose, Fraserburgh, and Aberdeen after 1905, which comprised nearly 80 per cent of the Scottish steam trawl fleet. This period is too short for a comparison of much value to the purposes of this report, but the data may be used to test in a measure the validity of the presumptions and discussions. The following table compares the percentile increases and decreases in the average catches of the trawlers from those ports per vessel and per landing:

INCREASE OR DECREASE IN QUANTITY PER VESSEL AND PER LANDING OF FISHES LANDED AT MONTROSE, FRASERBURGH, AND ABERDEEN BY STEAM TRAWLERS IN 1912, AS COMPARED WITH 1906.

Species.	Average catch per vessel.		Average catch per landing.	
	Hundredweight.	Per cent.	Hundredweight.	Per cent.
Demersal fish	−305	− 4.3	− 6.0	− 4.3
Cod	+198	+10.4	+ 4.1	+10.6
Haddock	−697	−21.9	−13.8	−21.8
Halibut	− 17	−36.0	− .3	−35.9
Plaice	− 27	−18.0	− .5	−17.3
Skate	+ 10	+ 5.5	+ .2	+ 5.5

The number of landings per vessel was practically the same in the two years and, therefore, the table shows an almost exact parallelism in the percentile changes calculated on the two bases and tends to confirm the general validity of deductions based on the average catch per vessel. It is quite probable that in other years the results would not be in such exact accord, but it is equally probable that the divergence would not be sufficient to change the trend of the whole series of apparent facts.

It has been seen that the landings of cod by steam trawlers on the east coast of Scotland have shown a practically continuous heavy increase in both aggregate quantity and the average per vessel during the period from 1891 to 1912. Haddock increased in total, but decreased in the average catch per trawler, while plaice displayed a practically continuous decrease in both.

There are no data which will show the proportions of the several trade sizes of these species for the east coast as a whole, but they are available for Aberdeen for the period from 1906 to 1912; and as the great majority of the steam trawlers hail from that port, an analysis of the statistics is of interest.

The records of the landings at Aberdeen indicate the general regions in which the fish were taken, and as the great majority of the voyages and but a slightly less proportion of the catch were made on the "east coast grounds," near Aberdeen, and on the northern grounds (Orkney and Shetland), the data respecting these two regions throw some light on the change of conditions of the fishery during the comparatively short period from 1906 to 1912.

The following tables compare the percentile ratios and the quantities of cod, haddock, and plaice of the several sizes taken by steam trawlers at Aberdeen in 1906 to 1908, inclusive, and 1910 to 1912, inclusive, respectively:

AVERAGE ANNUAL CATCH OF CERTAIN FISHES, IN HUNDREDWEIGHTS, PER STEAM OTTER TRAWLER AT ABERDEEN, SCOTLAND, 1906 TO 1908 AND 1910 TO 1912, RESPECTIVELY.

Species and sizes.	"East coast grounds."		"Northern grounds."	
	1906–1908	1910–1912	1906–1908	1910–1912
Cod:				
Large and medium	8.0	5.9	17.4	26.4
Small (codling)	4.9	7.2	15.1	31.0
Total	12.9	13.1	32.5	57.4
Haddock:				
Large	5.2	3.0	43.0	35.8
Medium	5.2	3.1	20.0	15.6
Small	21.1	16.6	42.3	26.0
Total	31.5	22.7	105.3	77.4
Plaice:				
Large	.08	.05	.51	.33
Medium	1.30	1.13	2.67	.70
Small	.18	.60	.15	.06
Total	1.56	1.78	3.33	1.09

AVERAGE ANNUAL PERCENTILE RATIOS OF SIZES OF CERTAIN FISHES TO TOTAL OF THE SAME SPECIES LANDED BY STEAM OTTER TRAWLERS AT ABERDEEN, SCOTLAND, IN 1906 TO 1908 AND 1910 TO 1912, RESPECTIVELY.

Species and sizes.	"East coast grounds."		"Northern grounds."	
	1906–1908	1910–1912	1906–1908	1910–1912
Cod:				
Large and medium	61.9	44.7	54.5	45.9
Small (codling)	38.1	55.3	45.5	54.1
Haddock:				
Large	16.6	14.2	41.3	46.4
Medium	16.2	13.8	18.9	20.1
Small	67.2	72.0	39.8	33.5
Plaice:				
Large	5.1	2.6	20.8	4.2
Medium	82.7	64.4	72.3	88.0
Small	12.2	33.0	6.8	7.8

On the "east coast grounds," which include the fishing grounds nearest to Aberdeen, to which the voyages were shortest, most frequent, and most numerous, and on which the catch per voyage was least, there has been an increase in the proportionate quantity of the small sizes of all three species. In the case of the cod there have been a decrease in the actual quantity of large cod and an increase in the small, the species as a whole remaining stationary. In the haddock both the total and the several sizes have decreased in average catch, with small decreases in the proportion of large and medium sizes, and a corresponding increase in the proportion of small ones. In the plaice there was an increase in the catch, owing solely to a material increase in the small, the take of the

other sizes having decreased both quantitatively and proportionately to the whole.

On the "northern grounds" both large and small cod increased very materially, but the latter, which formed but 45 per cent of the catch in 1906 to 1908, constituted 54 per cent in 1909 to 1912. All sizes of haddock decreased, but the large and medium categories were both of proportionately greater importance in the catch in 1909 to 1912 than in the earlier years, while the ratio of small fish to total haddock declined. There was a heavy quantitative decline in all sizes of plaice, but relatively the small, and especially the medium size, increased at the expense of the large fish.

It appears from the foregoing that all of these fish, excepting the cod on the northern grounds, show signs of depletion either in a quantitative decrease in the catch of large sizes of fish, or a relatively greater catch of small sizes accompanied by a stationary or decreasing catch of the species as a whole. The evidence is most emphatic respecting the plaice, less conclusive as regards the haddock, and contradictory in the case of the cod. The increase in the quantity and ratio of the catch of small cod on the northern grounds suggests increased attention to this species to compensate for some deficiency in other kinds, e. g., haddock and plaice. The period covered by this analysis is too short for the conclusions to carry great weight by themselves, but they are of value when considered with the deductions from other data previously examined.

SCOTCH LINE FISHERIES.

The number of line fishing boats and vessels on the east coast of Scotland can not be definitely determined from the reports, and the only data showing the extent of the fishery are those pertaining to the length of lines.

LENGTH OF LINES FISHED BY VESSELS OF ALL CLASSES ON THE EAST COAST OF SCOTLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Periods.	Length, in 1,000 yards.		Decrease.	
	First year.	Last year.	1,000 yards.	Per cent
1898–1901	54,989	46,320	8,669	15
1901–1903	46,320	40,230	6,090	13
1903–1906	40,230	39,047	1,183	3
1906–1912	39,047	32,888	6,159	16
1898–1912	54,989	32,888	22,101	40

The data are not available prior to 1898, but since then there has been a continuous and conspicuous decrease in the length of line. The smallest decrease occurred between 1903 and 1906, the only period in which the number of steam otter trawlers waned.

Unfortunately the various classes of lines, "great," "small," and "hand," while all exhibiting heavy decreases, did not maintain their ratios to one another, and as they differ materially in their fishing power unit of length and as the catch of each was not separately recorded in the reports, it is unsafe to venture conclusions on the data available.

Steam liners use more nearly one class of gear, great lines; and as, so far as the statistics show, the other kinds of lines were used in negligible quantities, the statistics of those vessels are more nearly comparable in the several years, and afford the only basis for a comparative study of the intensity of the line fishery.

LENGTH OF TRAWL LINES FISHED BY STEAM VESSELS ON THE EAST COAST OF SCOTLAND DURING THE FIRST AND LAST YEARS OF CERTAIN PERIODS.

Periods.	Length, in 1,000 yards.		Increase.	
	First year.	Last year.	1,000 yards.	Per cent.
1898–1901	1,474	3,195	1,721	117
1901–1903	3,195	3,542	347	11
1903–1906	3,542	6,050	2,508	71
1906–1912	6,050	11,702	5,652	93
1898–1912	1,474	11,702	10,228	693

While the total length of lines fished on the east coast of Scotland was decreasing, the length of the lines used by steam vessels was steadily and rapidly growing, but it was not until after 1903 that it exceeded 10 per cent of the total. In 1906 it comprised over 15 per cent, and in 1912 about 35 per cent. This kind of line was undoubtedly more effective per unit of length than that fished from the sailing vessels, and the catch of steam liners should be separately considered, but unfortunately the landings of these vessels were not separately recorded until 1906.

TOTAL QUANTITIES OF DEMERSAL FISHES TAKEN BY STEAM LINERS ON THE EAST COAST OF SCOTLAND IN 1906 AND 1912, RESPECTIVELY.

Classes and species.	1906	1912	Gain.	
			Hundredweight.	Per cent.
	Hundredweight.	*Hundredweight.*		
Total demersal fishes	162,195	255,414	93,219	57
Round fishes	109,481	161,679	52,198	48
Flat fishes	20,836	35,047	14,211	68
Skate	31,567	57,956	26,389	83
Unclassified	[a] 311	[a] 732	421	138
Cod	52,047	61,291	9,244	17
Haddock	114	345	231	202
Halibut	20,836	35,044	14,208	68

[a] Includes fishes classified since 1903.

There is here shown a percentile increase in the total catch of all categories and important species of demersal fishes, greatest among the unclassified fishes in respect to general categories and in haddock among the specific kinds. As this increase occurred pari passu, with a heavy increase in fishing activity or power, any significance which the facts presented may possess can be shown only by reducing the data of the two years to a comparative basis.

Two standards of fishing activity suggest themselves—the length of line employed in the respective years and the number of landings, but the two sets of results obtained by reducing the total catch to the average per 1,000 yards of line and the average per landing at those ports in which both are obtainable are contradictory and unreconcilable on any basis of which we have been able to conceive. This throws doubt on any deductions which might be drawn in respect to the data pertaining to the east coast steam liners as a whole. The uncertainties as to the lengths of the voyages on the one hand and to the character of the lines fished on the other make a further discussion futile, and the subject is mentioned here merely to show that it has been considered.

CHANGES IN THE UNCLASSIFIED FISHES.

The Scottish reports distinguish between two general groups of demersal fishes, classified and unclassified, the former including round fishes, flat fishes, and skates. The classified fishes embrace all of the more important kinds, which in most cases are separately designated, while the unclassified fish comprise a miscellaneous lot not separately listed and of minor importance in both quantity and value.

Until 1903 there were but 11 or 12 species in the classified lists, but in 1904 a number of species were transferred from the unclassified category, the total quantity of which was thereafter somewhat reduced to the benefit of the other categories. These changes are in themselves significant, but when accompanied by an increase in the ratio of unclassified to demersal fishes as a whole they indicate that the supply of classified fishes is unequal to the demand; and when the catch of certain species, as for instance the haddock and the plaice, exhibit a falling off, as has been shown in preceding pages, it means not that the commercial incentive to catch them has been lessened, but that the supply is insufficient.

This subject need not be considered further here than to say that since 1904, when the unclassified fishes were reduced by transfer, their ratio to all demersal fishes has increased from 0.5 per cent to 4.2 per cent in 1906, 4.9 per cent in 1910, and 4.6 per cent in 1912.

SUMMARY, EAST COAST OF SCOTLAND.

On the east coast of Scotland demersal fishes and round fishes both showed a continuous increase in the quantities landed from 1891 to 1912, and flat fishes increased until 1901, after which they decreased. These increases are due largely, if not wholly, to the development of steam trawling, which was responsible for about 25 per cent of the catch in 1891, 75 per cent in 1901, and about the same in 1912. The total catch of the trawlers, therefore, follows the same course, although the increases are heaviest between 1891 and 1901, when the fleet was developing most rapidly.

Neither the average length of the voyages nor the number of days' absence in the several years are known, and the only basis for the determination of the catch per unit of effort is the catch per annum per trawler. With some fluctuations this has shown an increase in respect to both demersal fishes as a whole and round fishes, and an almost continuous and material decrease in flat fishes. As has been shown elsewhere, this does not furnish a very satisfactory basis for comparison, as the effects of vessels lying idle for indeterminate and possibly important periods are not eliminated.

As in England, cod, haddock, and plaice are the most important species, and of these the latter is recorded in combination with two other species, neither of which, however, is quantitatively of much relative importance. Of these the cod has almost continuously increased in the average catch per vessel, and the net gain from 1891 to 1912 was large. The haddock has fluctuated, but in most years the average catch per vessel was higher than in 1891, although a heavy fall in 1912 caused a net decrease of 41 per cent for the entire period. The plaice, including the flounder and the brill, has decreased almost continuously, and the catch of 1912 was but 14 per cent of that of 1891. At a few ports where the number of landings has been given in later years, the average catches per voyage in 1912, as compared with 1906, showed an increase of 10 per cent in cod, a decrease of nearly 22 per cent in haddock, and a decrease of 17 per cent in plaice. As to the proportions of the several sizes of these fishes, data are available for the landings at Aberdeen, whence hail the majority of the trawlers, but for recent years only. The catch on the "east coast grounds" in near-by portions of the North Sea exhibited an increase in the proportionate quantity of the small sizes of all three species. From the region of Orkney and Shetland, on the northwest border of the North Sea, large cod and plaice decreased proportionately to the whole, while large and medium haddock increased somewhat. While all of the foregoing applies to fish landed on the east coast of Scotland from all regions, most of them came from the North Sea, concerning which, it may be said, there-

fore, that there is strong evidence of a depletion of the plaice and some evidence of a falling off in the haddock, the two most distinctly trawl-caught fish.

SUMMARY AND CONCLUSIONS.

1. Otter trawls do not destroy the spawn of the commercially important demersal fishes, all of which have pelagic or floating eggs.

2. Otter trawls do not seriously disturb the bottom over which they are fished nor materially denude it of the organisms which directly and indirectly serve as food for commercial fishes.

3. The investigations conducted by the Bureau of Fisheries indicated that during 1913 trawling interfered but little with line fishing and caused practically no damage to the trawl lines. From the nature of the two fisheries, however, it is believed both can not be extensively conducted on the same grounds without resultant accidental damage to or interference with the lines, especially in foggy weather.

4. Otter trawls as compared with lines take a much larger proportion of commercial fishes too small to market. From January to May 3 per cent of the cod and 11 per cent of the haddock, and from June to December 40 per cent of the cod and 38 per cent of the haddock were unmarketably small, while the lines caught practically no such fish. These proportions were fully maintained in the respective classes of vessels fishing at the same season on the same grounds. These young fish are practically all destroyed.

5. Otter trawls as compared with trawl lines market a much larger proportion of small fish, and, therefore, they not only destroy more small fish not utilized, but are biologically more wasteful, by reason of the smaller size of the marketable fish. As, however, a large proportion of these smaller fish would undoubtedly die or be destroyed under natural conditions before reaching the large or medium size, the effects on the total supply of fish are less to a conceivable, but at present indeterminable, degree than the data presented would indicate.

6. Practically the only food fish which the otter trawl has added to the present yield of the fisheries on the banks is the "sole," of which about 600,000 pounds were caught in 1913. This is equal to about three times the quantity of hake, 36 per cent of the cod, and 5 per cent of the haddock, or about 4 per cent of the three combined marketed by the trawlers. On the other hand, it is estimated that this is less than one-third of the weight of the immature cod, haddock, and hake destroyed by otter trawls. The trawlers have not added greatly to the food supply by the introduction of fishes not previously taken in quantities by the liners. They may have conferred some benefit on the consumer by catching and marketing

larger quantities of the smaller and cheaper fishes of the cod family, provided, of course, that this does not induce the depletion of the ultimate supply. Both trawlers and liners catch considerable quantities of edible species for which they have failed to develop a market.

7. There is but little evidence to show that the introduction of the otter trawl in the American fisheries has had any material effect in keeping down the price of fish. Since 1898 there has been a gradual, although fluctuating, increase in the price received by the fishermen for all kinds of fish. The haddock has increased proportionately less than the other demersal fishes and since 1908 has kept close to or below the level of that year, and this is probably, to no small extent, due to the large quantities of small and cheaper fish landed by the trawlers. The catch of the American trawlers, however, is too small in proportion to the total production of demersal fisheries to have a material effect on prices, and we have therefore examined the price statistics of England to determine what light they shed on the subject. We find that while, apparently, the otter trawl reduced the cost of production of fish for a number of years after it become paramount in the fishery of that country, it did it to some extent by reducing the standards of size, and that recently there has been a rapid increase in the prices of fish which are now higher than ever. Undoubtedly the general increase in commodity prices has had some effect.

8. We have been unable to discover from the examination of official records, extending from 1891 to 1914, any evidence whatever that the banks frequented by the American otter trawlers are being depleted of their fishes. Since 1905 when the first steam trawler began operations off the New England coast there have been fluctuations in the total yield of the bank fisheries, but they have been no more violent nor significant than in the period before 1905 when lines alone were used. In fact, some of the heaviest yields recorded in the line fishery have been made in years since the otter trawl was introduced, and, while the catch of line fishemen in 1914 on Georges Bank, South Channel, and Nantucket Shoals, where the otter trawlers operate, was less than half of that in the extraordinary year 1905, this was accompanied by a proportionate reduction in the intensity of the fishery as measured by the number of trips to these grounds. The average catches per trip of haddock and of cod, haddock, and hake combined have been considerably higher since 1910 than for any similar period of which we have record. The average catch of cod per trip to these banks has decreased since 1910, but it is higher than for any similar period prior to the introduction of otter trawling. As the liners catch, proportionately, more cod and the trawlers more haddock on these banks, and as quantitatively the liners catch

more of each, the statistical facts of the fishery certainly do not indicate that it has yet shown signs of depletion from the use of the otter trawl.

9. We recognize that the conclusions arrived at in the preceding section are necessarily inconclusive for the reason that the otter-trawl fishery in American waters is too recently established and relatively too small to have had a very material effect on the fish supply of the banks frequented. We have therefore examined the accessible data relating to the fishery in England and Scotland, particularly that conducted in the North Sea, where it is most intensive and has been longest established. We have used the data without reference to the opinions others have expressed and have endeavored to arrive at independent conclusions without prejudice from previous investigations of the subject. While the statistical information, particularly that contained in the English reports, is more useful for the purpose than is that pertaining to our own fishery, it is in recent years only that it is given in sufficient detail. Proof respecting the depletion of the fisheries, on the contrary, can not be deduced. The most possible has been the establishment of more or less strong presumptions one way or the other.

10. The cod, haddock, and plaice are the most important and abundant of the demersal fishes of the North Sea, and the three combined comprise about 75 per cent of the catch. English vessels take between 50 and 60 per cent of the total of these species landed from the North Sea, and the English trawlers alone take from 45 to 50 per cent. These three fishes are, therefore, the only ones which it is important to consider.

The statistical data of the English fisheries indicate by a decrease in the total catch, in the average catch per unit of effort, and in the proportion of large fish to the total that probably the plaice fishery is being depleted. The first two criteria also point to a decrease in the haddock, and it is believed that the third test fails to do so only because a lowering in the standard of sizes makes the statistics in this particular misleading. The cod does not show indications of overfishing, probably because its different habits make it less vulnerable to the effects of the predominant fishery, steam trawling.

The statistics of Scotland are less satisfactory for our purpose than are those of England, and it is not possible to obtain sufficient separate data for the North Sea. We have therefore considered the fuller information obtainable in respect to the east coast, the fishery of which is prosecuted mainly in the North Sea. The same three species are discussed, the catch of these by Scotch vessels in the North Sea proper constituting about 25 per cent of the total yield of the three in that sea. The plaice show signs of depletion

in the heavy decrease of the total yield and of the average catch per vessel and in the proportion of large fish to the smaller sizes. While the haddock has increased in the total catch, the average catch per vessel has fluctuated to an extent which makes any deductions from the data uncertain; and there is a small decrease in the relative proportion of large fish compared with the total. The cod has increased in total catch and in the average catch per vessel, but relatively fewer larger fish were taken in later years.

Considering the English and Scotch fisheries in the North Sea together, there is a strong presumption of overfishing in the case of the plaice, considerable evidence of the same thing in respect to the haddock, and practically none concerning the cod. As the steam trawler is overwhelmingly predominant in the fisheries for these species, it must be held responsible for such overfishing as may have occurred.

11. Three regions other than the North Sea support more or less important English trawl fisheries yielding essentially the same species which have been discussed. They are Iceland, the White Sea, and the Faroe Islands. Separate data concerning them are available for years subsequent to 1905, and while the period covered is too short to admit of deductions of much value, it has been employed for purposes of comparison with the North Sea.

In Iceland the total catch of both haddock and plaice and the average catch of each, especially the latter, showed heavy decreases, while the cod increased. In all species, but particularly the plaice, there was a decrease in the proportion of large sizes to the total.

In the White Sea the total catch of all species increased from 1906 to 1912, but this was in part due to an increase in fishery activity. As measured by the quantity caught per trip there was an enormous increase in cod, a heavy increase in haddock, and a heavy decrease in plaice. The proportion of large fish was approximately maintained in the cod and plaice but was much smaller in later years in the case of the haddock, thus indicating that the increase in the catch of that species was due to the saving of smaller fishes previously discarded or unsought.

In the Faroes there was a slight increase in the average catch of cod per trip, owing mainly to an increase in the smaller sizes, and a decrease in the haddock, accompanied by a similar increase in the take of smaller fish. The catch of plaice was negligible in all years.

The data from these regions are therefore in general confirmatory of those relating to the North Sea, namely, that there is a presumptive decrease in the plaice, a probable smaller decrease in the haddock, and little or no change in the numbers of cod.

12. The North Sea embraces an area of about 152,000 square miles, which is not all equally productive and part of which is resorted to not at all or very little by English and Scotch trawlers. Georges Bank, South Channel, and Nantucket Shoals cover about 9,800 square miles, a considerable but indeterminate part of which is not resorted to by fishermen and presumably not by fishes in large numbers.

In 1913 English and Scotch (Aberdeen) otter trawlers only made 50,590 fishery trips to the North Sea. Assuming the entire area of the sea to have been fished, there was one trip to each 3 square miles. In the same year 326 trips to Georges Bank, South Channel, and Nantucket Shoals were made by American otter trawlers, which therefore had 30 square miles of bottom to each trip.

This unsatisfactory comparison is the best that we can give of the relative intensity of the otter-trawl fishery in the North Sea and on the banks frequented by the American trawlers. In the estimate respecting the North Sea some unproductive bottom is included and the trawlers of other nationality than the British are omitted, and the estimate of 3 square miles is too high. In the case of the American banks a considerable unproductive area is also included, and while all trawlers are taken into account the estimate of 30 square miles is also too high, but in neither case can we estimate the error. The most specific information concerns the Dogger Bank, having an area of 6,216 square miles, to which English trawlers made 2,196 trips in 1913, or approximately a trip to each 3 square miles.

RECOMMENDATIONS.

While the facts before us show no proof or presumption of any depletion of the fisheries on the banks frequented by American otter trawlers, it is possible that the seeds of damage already have been sown and that their fruits may appear in the future or that the development of a wholly unregulated fishery eventually may result in injury where none now exists. The matter presented for our consideration is the safeguarding of the food supply not only of the existing but of coming generations, and we are therefore less concerned with present conditions than with those which may develop, less with the immediate interests of the parties to the controversy respecting otter trawling than with the ultimate interests of the entire country in the perpetuation of some sort of productive fishery for all time.

We have in the history of our own bank fisheries sufficient information to warrant the belief that there is but little danger of their depletion by line fishing as at present conducted, but there is no such accumulation of data respecting the recently introduced otter

trawl; and for an indication of what may be expected from it we must have recourse to the history of the fishery in other places. Otter trawling has been practiced longest and has attained its greatest development in the North Sea, where there appears to be ample evidence that it is being carried on to excess and that the fisheries for certain fishes have suffered in consequence. The problem before us, therefore, is to suggest measures for the prevention of the development of similar conditions in the American fisheries.

The injurious effects of the otter-trawl fishery in the North Sea are believed to be in part due to the destruction of large numbers of small fish, and it has been proposed by certain European authorities to reduce its destructiveness by increasing the size of the meshes of the net to dimensions which will permit the escape of fishes too small to market. We do not regard this as an effective or feasible proposal for the reasons (1) that the meshes tend to close as the drag on the net increases with its burden, (2) that the accumulation of fishes in the cod end closes the avenues of escape there, and (3) that the fishes in any event would not attempt to pass through in large numbers until the net is being hauled in, when the possibility of escape would be reduced to a minimum. An increase in the size of the mesh in the cod end of the net would probably result in an increase in the number of fish gilled, thus not only inducing little mitigation of the destruction of young fishes but entailing additional labor in fishing the apparatus.

There remain three other methods of regulation: The absolute prohibition of the use of the otter trawl or similar apparatus; the restriction of the number of nets or vessels which may be employed; and the restriction of the area on which the apparatus may be used.

The first and most drastic measure would of course be most effective, but in view of the fact that it appears to be the excessive use of the otter trawl which has caused injury to the North Sea we do not regard it as justifiable to prohibit its use on the American banks where it is not yet shown to be injurious. In other words, our present information indicates that it is not fishing with the otter trawl but overfishing which is to be guarded against. The fact that it is undoubtedly more destructive than line fishing is not sufficient for its condemnation, for the same objection can be raised with more or less validity to almost any other net fishery, and we do not know to what extent the destruction of young fishes in the open seas in reality injures the fisheries.

The regulation or restriction of the number of vessels or trawls permissible in the fishery we regard as objectionable for the reason that it would establish an actual or virtual monopoly. The regulation could be made effective only by the issuance of a limited number

of licenses or permits, and this would involve either some selection or discrimination among the applicants by the issuing authority or an undiscriminating issuance of permits to the earlier applicants and their refusal to those making application after the predetermined number had been granted.

The restriction of the use of the otter trawl to certain definite banks and grounds appears the most reasonable, just, and feasible method of regulation which has presented itself to us.

It would have the effect of automatically placing some limitation on the number of vessels engaged in the fishery, for the reason that caution would be imposed on prospective investors by virtue of their knowledge that no other fishing grounds were open to exploitation if those allotted to them should be exhausted.

It would cause the trawlers, for reasons of self-interest, to exercise care to reduce as far as possible such abuses or economic defects as may be inherent in the method and to eliminate those which are not essential to it. The results of offenses against good fishery practices would be imposed directly on the prime offenders and would be mitigated to those using other methods by their freedom of resort to other areas where the evils would be manifested little or not at all.

Any injury to the fishery which might result from the development of otter trawling under such restriction would be localized. It would manifest itself chiefly on the banks to which the fishery might be restricted and, especially in respect to the haddock, the fish likely to be most severely affected, would extend but little or not at all to the banks from which the otter trawl might be excluded. Therefore neither the whole, nor even the major part of our bank fisheries, could be depleted by any conceivable development of otter trawling under such restraint.

Being thus localized, inherent evils would more certainly manifest themselves, the effects could be more closely observed and more quickly and surely detected, the fishery could be kept under closer and more accurate observation, and it would be possible by comparison with the conditions on the proscribed banks to discriminate in some measure between accidental fluctuations in the abundance of the fishes and those which might be due to overfishing.

We therefore recommend that the taking of fishes, excepting shellfishes, by means of the otter trawl or beam trawl, or any adaptation or modification of either, or by any other apparatus drawn over the bottom by a vessel in motion, be prohibited on all bottoms in the Atlantic Ocean, outside of territorial jurisdiction, north of the fortieth degree of north latitude, excepting Georges Bank, South Channel, and Nantucket Shoals east of the meridian of Sankaty Head on the island of Nantucket.

This will retain to the otter trawlers sufficient ground on which to prosecute their calling, it will not exclude the liners therefrom, and it will reserve to the latter exclusively the banks to which they make over two-thirds of their trips. It gives a large measure of absolute protection to the important line fisheries of New England, and at the same time will permit the development of an otter-trawl fishery for flounders and other bottom fishes from New Jersey southward on bottoms where they are not, and probably can not be, taken in large quantities by any other means. The flounder fishery of Massachusetts being conducted in territorial waters will not be interfered with. The regulation can be readily enforced, because the open areas are well known, well defined, and can be kept under surveillance. Moreover, every line fisherman in the area affected will be a self-constituted fish warden, prompted by every motive of self-interest to bring infractions of the regulation to the attention of the proper authorities.

It must be understood that this recommendation is based on what we believe to be the conditions at this time. Next year or 10 or 20 years hence they may be different, and it will be necessary to closely observe the developments of the future to the end that a situation shall not arise such as has arisen in the North Sea, which will be recognized as requiring correction, but which will present such far-reaching and important economic aspects as to make rectification difficult or impossible.

In conclusion, we emphatically state it to be our opinion that this regulation will prove futile and an unnecessary imposition on American fishermen unless Canada, particularly, and, possibly, Newfoundland and France will take such action as will prevent or restrict the use of the trawl on the banks in the western North Atlantic.

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